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NATIONAL SERVICE TRAINING

Motorola National Service Training
California Department of Transportation
Course Outline

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MOTOROLA

Synthesser
9.6 v
5v
8.6 v
address
data
strobe

14.4 mhz
6.25 khz ref
if all ok open loop JU600
source 3 - 5 v to VCO

NST
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TRAINING

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Mod Acceptance
adj gen for 12db sinad
incr rf out 6db
incr dev for 12db sinad
read dev = mod accept

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MOTOROLA
Mobile Products Division

SYNTOR X 9000E
Dual Operation Radio System

Instruction Manual

68P80101W62–B

MOTOROLA
Mobile Products Division

SYNTOR X 9000E
Dual Operation Radio System

Contents

technical publication services
5555 North Beach Street, Fort Worth, Texas 76137
68P80101W62–B
7/31/89

Foreword

1. Scope of Manual

This manual is intended for the use of experienced technicians familiar with this general type of equipment. In it you should be able to find all the information you will need for installing and servicing the equipment it covers. It is current as of the publication date, and incorporates changes that have occurred since then in the form of instruction manual revisions (WMR's). (WMR's that cover production or engineering changes to the circuitry usually include corrected schematics and circuit board diagrams.)

2. Model and Kit Identification

Each Motorola product has an identifying model number stamped on its nameplate. In most cases, assemblies and kits that make up the product also have identifying kit numbers stamped on then. Schematics and circuit board diagrams for such kits show this same identifying number prominently in the lower left–hand or right–hand corner.

3. Service

Motorola's national service organization maintains one of the finest nation–wide installation and maintenance programs available to users of communication equipment. The administrative staff of this organization consists of national, area, and district service managers, all of whom are Motorola employees dedicated to giving our customers the best possible service. The organization has about 900 authorized Motorola Service Stations (MSS's) throughout the United States, each manned by one or more trained, FCC–licensed technicians.

Motorola selected each one of these independently owned and operated MSS's to service its customers. They offer Motorola maintenance either by the job (priced by time and material), or on a service contract at a fixed periodic fee. To buy a service contract for your Motorola equipment, contact your Motorola Service Representative or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Algonquin Road
Schaumburg, Illinois 60196

4. Ordering Replacement Parts

When ordering replacement parts (components, kits, or chassis) or equipment information, include the complete identification number. If the component part number is not known, include in your order the number of the chassis or kit of which it is a part, and enough component description to identify the desired part.

In orders for crystal and channel elements, specify the crystal or channel element type number, crystal and carrier frequency, and the model number of the radio in which the part is used.

In orders for active filters, *Vibrasender* and *Vibrasponder* resonant reeds, specify type number and frequency, and identify the owner/operator of the communications system in which these items are to be used; also include any serial numbers stamped on the components being replaced.

Replacement Parts Ordering

MAIL ORDERS

Send written orders to the following addresses;

Replacement Parts, Test Equipment, Crystal Service Items:

Motorola, Inc.
Communications Parts Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Federal Government Orders:

Motorola, Inc. Communications Parts Division
Attention: Order Processing
1701 McCormick Drive
Landover, MD 20785

International Orders:

Motorola, Inc.
Communications Parts Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

TELEPHONE ORDERS

Replacement Parts/Test Equipment :

call: 1–800–422–4210
or Federal Government orders,
1–800–826–1913

Crystal Service Items :

call: 1–800–422–4210

TELEX/FAX ORDERS

Replacement Parts/Test Equipment/Crystal Service Items:

Telex: 280127
FAX: 312–576–6285

Federal Government orders:

FAX: 301–925–2473 or 301–925–2474

Customer Service

Replacement Parts/Test Equipment
call: 1–800–537–7007

Crystals
call: 1–800–323–0234
or Illinois residents
1–800–537–7007

Parts Identification
call: 312–576–7418

National Data Services

1711 West 17th Street, Tempe, AZ 85281

call; 602–994–6472
TWX: 910–951–1334

GENERAL SAFETY INFORMATION

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard that applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave, and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

INSTALLATION SAFETY WARNING

Consider the occupants' safety when you choose a location for the radio. Do not mount the radio overhead or on a sidewall unless you take special precautions.

If someone were to remove the radio and fail to replace it properly, road shock could bump the radio loose, and the falling radio could in some circumstances cause serious injury to the driver or a passenger.

If you must mount the radio overhead or on a sidewall, give it the added protection of a retaining strap. Custom–made straps are available from Motrola National Parts. Order kit number HLN4698A (for *Mitrek* and *MaraTrac)* or HLN4697A (for *SYNTOR, SYNTOR X,* or *SYNTOR X 9000*).

WARNING

For vehicles equipped with electronic anti–skid braking systems, see "ANTI–SKID BRAKING PRECAUTIONS" Publication, Motorola Number 68P81109E34.

WARNING

To gain full access to the Common Circuits Board (*Mitrek, SYNTOR* Products Only) for servicing, the regulator heat sink screw must be removed. When operating the radio with the regulator heat sink screw removed, care should be taken to avoid the exposed hot flange.

WARNING

It is mandatory that radio installations in vehicles fueled by liquefied petroleum gas conform to the following standard.

National Fire Protection Association standard NFPA 58 applies to radio installations in vehicles fueled by liquefied petroleum (LP) gas with the LP–gas container in the trunk or other sealed–off space within the interior of the vehicles. This standard requires that:

1. Any space containing radio equipment shall be isolated by a seal from the space in which the LP–gas container and its fittings are located.

2. Remote (outside) filling connections shall be used.

3. The container space shall be vented to the outside.

FCC Requirements

The Federal Communications Commission (FCC) requires that you obtain a station license for your radio equipment before transmitting. No operating license or permit is required. The station licensee is responsible for ensuring that the transmitter power, frequency, and deviation are within limits defined by the station license.

The licensee of the station is at all times responsible for the proper operation and maintenance of the current station authorization. You must measure the power output and record the results:

- when the transmitter is first installed
- when the transmitter is changed in any way that may increase the power input
- at least once a year.

You must check the frequency and deviation of the transmitter:

- when it is first installed
- when the transmitter is changed in any way that might affect the carrier frequency or modulation characteristics.
- at least once a year.

Service

To purchase a service contract for your Motorola equipment, or to purchase additional manuals, contact:

National Service Manager
Motorola Communications Group
1301 E. Algonquin Road
Schaumburg, Illinois 60196

Safe Handling of CMOS Integrated–Circuit Devices

Many of the integrated–circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open–circuit impedance, CMOS IC's are vulnerable to damage from static charges. Everyone involved in handling, shipping, and servicing them must be extremely careful not to expose them to such damage.

CMOS IC's do have internal protection, but it is effective only against overvoltages in the hundreds of volts, such as those that could occur during normal operations. Overvoltages from static discharge can be in the thousands of volts.

When a CMOS IC is installed in a system, the system's circuit elements distribute static charges and load the CMOS circuits. This decreases the vulnerability of the IC's to static discharge, but improper handling will probably cause static damage even when the IC's are so installed.

To avoid damaging CMOS IC's, take the following precautions when handling, shipping, and servicing them.

1. Before touching a circuit module, particularly after having moved around in the service area, touch both hands to a bare metal earth–grounded surface. This discharges any static charge you may have accumulated.

Note

Wear a conductive wrist strap (Motorola Part No. RSX–4015A) to minimize the buildup of static charges on your person while you are servicing CMOS equipment.

WARNING

When wearing a conductive wrist strap, be careful near sources of high voltage. By grounding you thoroughly, the wrist strap also increases the danger of lethal shock from accidental contact with such a source.

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2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Check the INSTALLATION and MAINTENANCE sections of the service manual and the notes on the schematic to find out whether or not you can insert or remove circuit modules with power applied to the unit, and act accordingly.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and the wearing of static–generating clothing.

5. Be sure that all electrically powered test equipment is grounded. Attach the ground lead from the test equipment to the circuit module before connecting the test probe. Similarly, disconnect the test probe before removing the ground lead.

6. When you remove a circuit module from the system, lay it on a sheet of aluminum foil or other conductive surface connected to ground through 100,000 ohms of resistance.

WARNING

If the aluminum foil is connected directly to ground, you may get a shock if you touch it and another electrical circuit at the same time.

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7. When soldering, be sure the soldering iron is grounded.

8. Before connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary during the replacement of an integrated–circuit device), be sure to discharge any static buildup on your person (see Procedure 1, above). Because you can have a voltage difference across your body, you should use only one hand if you must touch the board wiring or any of the pins on the CMOS device.

9. When replacing a CMOS integrated–circuit device, leave the device in its metal rail container or conductive foam until you are ready to insert it into the pronged circuit module.

10. Connect any low–impedance test equipment such as a pulse generator to CMOS device inputs after you have applied power to the CMOS circuitry. Similarly, disconnect such low–impedance equipment before turning off the power.

11. Wrap CMOS modules in conductive material when transporting them from one area to another, even within the same room. Use wrapping material similar to that in which replacement modules are wrapped when they arrive from the factory. (You can also use aluminum foil.) Never use nonconductive material for packaging these modules.

Model Chart for "BK" Suffix *SYNTOR X 9000E* 800 MHz Radios

CODE:

- ∅ = BREAKDOWN IN A SEPERATE CHART
- ● = ONE ITEM SUPPLIED
- ⊕ = ONE ITEM SUPPLIED, DEPENDS ON OPTION
- ⊗ = ONE ITEM PER 10 UNITS

MODEL T35FDJ7J04BK	MODEL T35FXJ7J04BK	MODEL T45FDJ7J04BK	MODEL T45FXJ7J04BK	ITEM	DESCRIPTION
					DESCRIPTION
∅	∅	∅	∅		UNIFIED CHASSIS
∅	∅	∅	∅		MICROPHONE
∅	∅	∅	∅		CONTROL UNIT
●		●		HKN4241A	POWER CABLE, 17' NEGATIVE GROUND
	●		●	HKN4256A	POWER CABLE, 17' NEGATIVE GROUND WITH KEYLOAD
●	●	●	●	HKN4238A	INTERCONNECT CABLE
●	●	●	●	HLN4921A	BREAKAWAY TRUNNION
●	●	●	●	HLN4022C	INSTALLATION KIT
●	●	●	●	HLN4243A	BOTTOM COVER
⊗	⊗	⊗	⊗	HLN4262A	TUNING TOOL
●	●	●	●	HLN4263A	TOP COVER
●	●	●	●	HLN4666A	MOUNTING TRAY
●	●	●	●	HLN5275A	NAMEPLATE
●	●	●	●	HLN4952A	FUSE KIT FOR GREEN AND ORANGE LEADS
●	●	●	●	RRA4900C	GAIN WAVE ANTENNA
●	●	●	●	HKN4051A	CABLE AND FUSE
●	●	●	●	HLN5095A	BLANK PUSHBUTTON
●	●	●	●	HLN5105A	HANDLE AND SHIELD
●	●	●	●	HLN1258A	TRUNKING OPTION CARD
●	●	●	●	HLN5216A	CONTROLLER CARD
●	●	●	●	HLN5365C	MEMORY CARD
●	●	●	●	HLN5254A	SOFTWARE
●	●	●	●	HLN5255A	EEPROM
●	●	●	●	HSN4018A	SPEAKER
⊗	⊗	⊗	⊗	HLN5064A	*SYSTEMS 9000* TOOLS
	●		●	HLN5092A	*SECURENET* PUSHBUTTON
●	●	●	●	HLN5066A	SCAN PUSHBUTTON
●	●	●	●	HLN5074A	CALL PUSHBUTTON
●	●	●	●	HLN5076A	RCL PUSHBUTTON
●	●	●	●	HLN5078A	DEL PUSHBUTTON
●	●	●	●	HLN5079A	SEL PUSHBUTTON
●	●	●	●	HLN5083A	EMER PUSHBUTTON
●	●	●	●	HLN5085A	SQL PUSHBUTTON
●	●	●	●	HLN5087A	HOME PUSHBUTTON
●	●	●	●	HLN5091A	DIR PUSHBUTTON
●	●	●	●	HLN5256A	SRCH PUSHBUTTON
●	●	●	●	HLN5268A	PAGE PUSHBUTTON
●	●	●	●	HBN4002A	PACKING
⊕	⊕	⊕	⊕	HVN4000A	*SMARTNET* SOFTWARE
⊕	⊕	⊕	⊕	HVN4001A	*PRIVACY PLUS* SOFTWARE

Model Chart for "CK" Suffix *SYNTOR X 9000E* 800 MHz Radios

CODE:

- ∅ = BREAKDOWN IN A SEPERATE CHART
- ● = ONE ITEM SUPPLIED
- ⊕ = ONE ITEM SUPPLIED, DEPENDS ON OPTION
- ⊗ = ONE ITEM PER 10 UNITS

MODEL	T35FDJ7J04BK	T35FXJ7J04BK	T45FDJ7J04BK	T45FXJ7J04BK	ITEM	DESCRIPTION
DESCRIPTION	NON-SECURE, 15W	*SECURENET*, 15W	NON-SECURE, 35W	*SECURENET*, 35W		
	∅	∅	∅	∅		UNIFIED CHASSIS
	∅	∅	∅	∅		MICROPHONE
	∅	∅	∅	∅		CONTROL UNIT
	●		●		HKN4241A	POWER CABLE, 17' NEGATIVE GROUND
		●		●	HKN4256A	POWER CABLE, 17' NEGATIVE GROUND WITH KEYLOAD
	●	●	●	●	HKN4238A	INTERCONNECT CABLE
	●	●	●	●	HLN4921A	BREAKAWAY TRUNNION
	●	●	●	●	HLN4022C	INSTALLATION KIT
	●	●	●	●	HLN4243A	BOTTOM COVER
	⊗	⊗	⊗	⊗	HLN4262A	TUNING TOOL
	●	●	●	●	HLN4263A	TOP COVER
	●	●	●	●	HLN4666A	MOUNTING TRAY
	●	●	●	●	HLN5275A	NAMEPLATE
	●	●	●	●	HLN4952A	FUSE KIT FOR GREEN AND ORANGE LEADS
	●	●	●	●	RRA4900C	GAIN WAVE ANTENNA
	●	●	●	●	HKN4051A	CABLE AND FUSE
	●	●	●	●	HLN5095A	BLANK PUSHBUTTON
	●	●	●	●	HLN5105A	HANDLE AND SHIELD
	●	●	●	●	HLN1259A	TRUNKING OPTION CARD
	●	●	●	●	HLN5216A	CONTROLLER CARD
	●	●	●	●	HLN5366C	MEMORY CARD
	●	●	●	●	HLN5254A	SOFTWARE
	●	●	●	●	HLN5255A	EEPROM
	●	●	●	●	HSN4018A	SPEAKER
	⊗	⊗	⊗	⊗	HLN5064A	*SYSTEMS 9000* TOOLS
		●		●	HLN5092A	*SECURENET* PUSHBUTTON
	●	●	●	●	HLN5066A	SCAN PUSHBUTTON
	●	●	●	●	HLN5074A	CALL PUSHBUTTON
	●	●	●	●	HLN5076A	RCL PUSHBUTTON
	●	●	●	●	HLN5078A	DEL PUSHBUTTON
	●	●	●	●	HLN5079A	SEL PUSHBUTTON
	●	●	●	●	HLN5083A	EMER PUSHBUTTON
	●	●	●	●	HLN5085A	SQL PUSHBUTTON
	●	●	●	●	HLN5087A	HOME PUSHBUTTON
	●	●	●	●	HLN5095A	PHON PUSHBUTTON
	●	●	●	●	HLN5091A	DIR PUSHBUTTON
	●	●	●	●	HLN5256A	SRCH PUSHBUTTON
	●	●	●	●	HLN5257A	LOCK PUSHBUTTON
	●	●	●	●	HLN5258A	SITE PUSHBUTTON
	●	●	●	●	HLN5259A	RPGM PUSHBUTTON
	●	●	●	●	HLN5268A	PAGE PUSHBUTTON
	●	●	●	●	HLN5435A	*SYNTOR X 9000E* BAG OF BUTTONS
	●	●	●	●	HBN4002A	PACKING
	⊕	⊕	⊕	⊕	HVN4000A	*SMARTNET* SOFTWARE
	⊕	⊕	⊕	⊕	HVN4001A	*PRIVACY PLUS* SOFTWARE

Model Chart for *SYNTOR X 9000E* 800 MHz Radio Unified Chassis

CODE:

● = ONE ITEM SUPPLIED

MODEL		DESCRIPTION						
		HUF1029C	HUF1046C					
		UNIFIED CHASSIS 806–870 MHZ, 35 WATT	UNIFIED CHASSIS 860–870 MHZ, 15 WATT					
		ITEM	DESCRIPTION					
●	●	HLN1253A	INTERNAL CASTING					
●	●	HLN5356B	TALKAROUND VCO					
●	●	TRN8868A	PREAMP					
●	●	TRN8869A	MIXER					
●	●	TRN8871D	VCO BUFFER					
●	●	TRN8872A	VCO INTERCONNECT					
●	●	TRN8873B	INTERNAL CASTING HARDWARE					
●	●	HLN4246A	CHASSIS HARDWARE					
●	●	HRN4000C	RF BOARD					
●	●	HLN5299B	PERSONALITY BOARD					
●	●	HLN4971C	COMMON CIRCUITS BOARD					
●	●	TRN4734A	ANTENNA SWITCH					
●	●	TRN8856A	DIRECTIONAL COUPLER					
●	●	TRN8857B	BUS WIRES					
●	●	HLN4259A	FRONT HARDWARE					
●	●	TRN8852A	PREDRIVER SUBSTRATE					
●		TRN8853A	DRIVER SUBSTRATE					
●	●	TRN8851A	IPA					
●		HKN4155A	35 WATT INTERCONNECT CABLE					
	●	HKN4154A	15 WATT INTERCONNECT CABLE					
●		TRN8854A	FINAL POWER AMPLIFIER, 35 WATT					
	●	HLN5107A	FINAL POWER AMPLIFIER, 15 WATT					
●		TRN8858A	PA HARDWARE, 35 WATT					
	●	HLN5108A	PA HARDWARE, 15 WATT					
●	●	TRN8850A	HARMONIC FILTER					
●	●	TRN8855B	METERING BOARD					
●	●	HLN4994A	TRANSFORMER BRACKET KIT					
●	●	HLN4217A	PA FEEDTHRU PLATE					

Model Chart for *SYNTOR X 9000E* Control Unit and Microphone

CODE:

● = ONE ITEM SUPPLIED

MODEL		DESCRIPTION						
		HCN1045A	HMN1061A					
		CONTROL UNIT	MICROPHONE					
		ITEM	DESCRIPTION					
●		HLN5104D	CONTROL UNIT CIRCUIT BOARD					
●		HLN5250A	CONTROL UNIT HARDWARE					
●		HLN5251A	CONTROL UNIT SOFTWARE					
●		HBN4036A	PACKING					
	●	HLN5389A	MICROPHONE HARDWARE					
	●	HLN5391A	MICROPHONE HANG–UP CLIP					
	●	HLN5459A	MICROPHONE CIRCUIT BOARD					

SYNTOR X 9000E Options Chart

Trunking or Conventional

Option	Description
W12	Pre–Amp (UHF only)
W20	Telephone Interconnect
W58	1/4 Wave Antenna (800 MHz only)
W70	Omit Antenna
W71	Omit Microphone
W87	Omit Speaker
W90	Omit Accessories
W101	Negative Ground Cable, 22'
W109	Handset with Hang–up Box
W116	External Alarm (includes cable and 2 relays)
W123	Antenna, 3.5 dB gain, UHF 406–512 MHz
W124	Antenna, 5 dB gain, UHF 406–512 MHz
W238	Omit Trunking Operation
W239	Noise Cancelling Microphone
W269	Electronic Siren/Public Address
W305	16 Systems / 8 Subfleets / 64 Modes
W306	15 Systems / 16 Subfleets / 8 Modes
W354	Trunked Status/Message (8)
W355	Trunked and *MDC–1200* Status/Message (8)
W374	Trunked and *MDC–1200* Status/Message (16)
W412	*MDC–1200* Selective Call Encode/Decode
W470	Hidden Switch
W496	Negative Ground cable, 10'
W589	Public Address
W591	Auxiliary Switch Panel
W688	Hidden Emergency Pushbutton
W709	25 Systems / 8 Subfleets / 32 Modes
W800	Front and Rear Controls
W814	*MDC–1200* Unit ID and Emergency Alert
W820	Selective *Call Alert*
W821	Wide Area Coverage (AMSS) (for *SMARTNET* Models Only)
W822	Dynamic Regrouping (for *SMARTNET* Models Only)
W826	Omit Emergency Alarm/Call (for *SMARTNET* Models Only)
W827	Omit Conventional Operation
W829	8 Systems / 16 Subfleets / 64 Modes
W941	*MDC–1200* Status/Message (16)
W946	Conventional Telephone /DTMF
W995	ZONE/MODE Control Unit
W996	SYSTEM/SUBFLEET Control Unit

SECURENET *Options*

W268	Code Storage Battery
W303	Dual Code Select
W304	Proper Code Detect
W391	Physical Security Housing
W793	Add *DVI–XL* Encryption
W797	Add *DVP*–XL Encryption

SYNTOR X 9000E Performance Specifications (806–870 MHz)

GENERAL

Number of Modes	248 mode configurations available to accommodate Mode–Select repeater talkaround, multiple repeater selection, and trunking.
Squelch Options	*Private–Line* and *Digital Private–Line* coded squelch are standard and available within the same radio unit. Carrier squelch is also available.
Primary Power	12 VDC, negative ground. Radio is supplied for operation with negative ground vehicles.
Dimensions	2.5" H x 11.5" W x 16.0" L (63.5 mm x 292 mm x 406 mm)
Weight	Approximately 22.5 lbs (10.2 kg). Shipping weight approximately 37.5 lbs (17 kg).
Metering	A single scale 0–50 microampere meter or Motorola portable test set can measure all circuits for checking and adjustments

Model	Frequency MHz	Minimum RF Power Out	Maximum Battery Drain: Standby (13.8V)	Maximum Battery Drain: Receive @ Rated Audio (13.8V)	Maximum Battery Drain: Transmit @ Rated Power
T45FDJ	TX806–825,851–870	35W	1.3A	3.5A	13.2A
T45FXJ	RX851–870	35W	1.3A	3.5A	13.2A
T35FDJ		15W	1.3A	3.5A	7.3A
T35FXJ		15W	1.3A	3.5A	7.3A

TRANSMITTER

Output Impedance	50 ohms
Spurious and Harmonic Emissions	More than 70 dB below carrier (for EIA spec., RS152B)
Frequency Stablility	+0.0002% reference frequency from –30°C to +60°C ambient (30°C reference)
Maximum Frequency Separation	19 MHz within each of two groupings
Modulation	15F2 and 16F3, +5 kHz for 100% @ 1000 Hz
Audio Sensitivity	0.080V +3 dB for 60% maximum deviation @ 1000 Hz
FM Hum and Noise	EIA Companion receiver response –55 dB
Method	RS152B response –45 dB
Audio Response	+1, –3 dB of 6 dB/octave pre–emphasis characteristic from 300 to 3000 Hz
Audio Distortion	Less than 2% @ 1000 Hz, 60% maximum deviation
FCC Designation	35W–CC5023–Licensable under FCC rules Part 90 for 15F2, 16F3, 20F3, and 16F9 emission 15W–CC5041–Licensable under FCC rules Part 90 for 15F2, 16F3, 20F3, and 16F9 emission

RECEIVER

Input Impedance	50 ohms
Spurious and Image Rejection	100 dB
Frequency Stablility	+0.0002% reference frequency from –30°C to +60°C ambient (30°C reference)
Maximum Frequency Separation	19 MHz
Selectivity EIA SINAD	+25 kHz; 80 dB +100 kHz; 90 dB
EIA Modulation Acceptance	+7.0 kHz minimum
Intermodulation EIA SINAD	80 dB
Sensitivity EIA SINAD 20 dB Quieting	0.25 uV 0.35 uV
Squelch Sensitivity	Carrier squelch (at threshold setting), fixed Tone–Coded and Digital–Coded are all 8 dBq.
Audio Output	15 watts @ less than 3% distortion into 8 ohms
FCC Designation	RC0246

CONTROL UNIT

Dimensions (excluding mounting bracket)	6.5" W x 3.375" H x 1.687" D (166 mm x 87 mm x 42 mm)
Weight	1 lb (456 g)
Current Drain	300 mA

SPEAKER

Dimensions (excluding mounting bracket)	5" W x 5" H x 2.5" D (127 mm x 127 mm x 63 mm)
Weight	1.5 lb (680 g)

1. Introduction

The *SYNTOR X 9000E* Dual Operation Communications Systems consist of control stations, mobile units, base repeaters, and a system central controller. The systems operate in either a trunked or a conventional mode. (The term "trunked" essentially means the "automatic sharing" of a group of communications paths (trunks) among a large number of users.) The *SYNTOR X 9000E* Dual Operation Communication Systems provide a variety of features and capabilities many of which cannot be obtained in conventional systems alone.

2. Trunked Features

The major features of trunked operation are:

- System manager capabilities.
- System user capabilities.
- System reliability capabilities.
- System access features.
- System expansion features.

2.1 SYSTEM MANAGER CAPABILITIES

FCC Docket No. 18262 stipulates that users or system operators needing six or more channels in the 800–MHz spectrum will be required to operate trunked systems. Moreover, trunked systems from a minimum of 5 channels to a maximum of 20 channels are authorized. Motorola's basic trunked system consists of 5 channels, but is provided with the built–in capability of being expandable up to 20 channels.

2.2 USER CALL CAPABILITIES

2.2.1 Subfleet Calls

The subfleet call is the basic element that is served by the Trunked Communications Dual Operation System, and the subfleet call is the standard call capability. A subfleet call allows all the radios to monitor and initiate transmissions within the subfleet only. This provides the effect of a private channel down to the subfleet call.

2.2.2 Fleet Call

Fleet call allows the user of a Motorola *SYNTOR X 9000E* Dual Operation Communications System to initiate communication with all members of the fleet simultaneously without regard to subfleet boundaries. The system central controller monitors any subfleet call made within the fleet on a FIFO (first–in–first–out) basis. Fleet privacy is insured since no two fleets would ever be assigned the same voice channel at the same time, thus making it impossible for any units in one fleet to interfere with those of another fleet. This eliminates the need to monitor other users before starting transmissions. (See Figure 1 for a typical fleet/subfleet configuration.)

A Mode selector allows mobile units of the same fleet to selectively move between subfleets within the fleet. Moreover, the dispatchers (and select mobile stations) can be given both fleet–call and subfleet–call capabilities by means of a single selector switch. Fleet call in a subdivided fleet allows the dispatcher or mobile operator to transmit a message to all the units in his fleet without regard for subfleet boundaries.

The fleet and subfleet selections are made via the Mode selector. The basic control station can be programmed either to operate within a specified subfleet or be given a fleet call capability so that its transmissions would be heard in all subfleets, and its receiver would monitor activity in all subfleets on a FIFO basis.

A trunked control station equipped for multiple subfleet operation receives only one subfleet at a time. Consequently, if the dispatcher sets his Mode selector to one subfleet, he does not receive calls originating in a different subfleet. The same holds true for fleet call operations. If there is simultaneous operation in different subfleets, a trunked control station placed in the fleet–call mode receives only one subfleet, since the control station receives the subfleets on a FIFO basis. Multiple control stations allow the dispatcher to hear calls in more than one subfleet simultaneously.

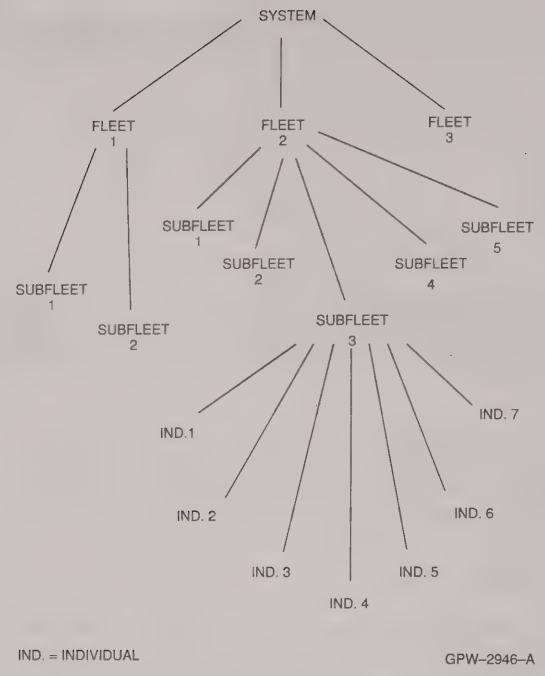


Figure 1. Typical Fleet/Subfleet Configuration

2.3 SYSTEM RELIABILITY

2.3.1 Multiple Channels

The multi–channel aspect of the *SYNTOR X 9000E* Dual Operation Communications Systems provide a high degree of system reliability. Since channels are assigned as needed and no user is dependent on any given channel for his communications, the failure of any one channel is probably not apparent to the users.

When a channel fails, the system controller is programmed to assign only the working channels. Only during the busiest periods of the system would the users notice heavier–than–normal channel loadings and longer user access times caused by the loss of a channel.

2.3.2 Back–Up Control Channels

The failure of an individual channel would not (in most cases) lead to a degradation of a system performance. If the control channel fails, however, the whole system could go off the air. To prevent this, the system controller is programmed to assign one of the voice channels as a substitute control channel. Under such conditions, the mobile units recognize the new control channel and system operation proceeds without interruption.

2.3.3 Receiver Interference

A trunked repeater may be jammed by the receipt of an unauthorized signal. The controller is programmed to turn off the repeater whenever it detects a carrier on a channel that has not been assigned to members of the system. The repeater is re–assigned only when the unwanted carrier is removed.

2.3.4 Transmitter Power Loss

The system controller is programmed to detect any loss or reduction in the output power of any of the repeater transmitters. When the transmitter output power falls below a certain level, the channel is automatically taken out of service.

2.3.5 System Self–Diagnostics

The system self–diagnostics comprise central controller checks, repeater receiver interface checks, and repeater transmitter interface checks. The detection of a fault can trigger visual and/or audible alarms at the controller site. Relays are used for implementing these alarm functions.

2.3.6 Failsoft

A failsoft feature has been incorporated into the system to ensure continued communications whenever the System Central Controller develops a fault. When the controller becomes inoperative, the mobile units automatically revert to their preassigned failsoft channels (system voice channels) and are capable of conventional repeater operation of these channels. Once in the failsoft mode, however, the system loses most of its fleet and subfleet privacy, but this privacy resumes as soon as normal system operation is restored. A warning tone sounds every ten seconds and "FAILSOFT" alternates with the mode name on the display during failsoft operation.

A subaudible data handshake is activated on each voice channel whenever the repeaters go into failsoft mode. This insures that the mobile units do not operate in the failsoft mode simply because they went out of range of the central. Thus the mobile units remain operative as long as they receive the subaudible data.

Since failsoft channel assignments are a function of the mobile unit code plug, they must be specified at the time of code plug programming. These assignments are made so that all the system mobile units are evenly distributed over the system voice channels. Members of the same fleet or subfleet should be as signed to the same channel. Mobile units can be denied failsoft operation.

2.4 SYSTEM ACCESS FEATURES

2.4.1 Talk Prohibit Tones

There will be times when all the channels in the trunked communications system are busy. Since it is not possible to monitor other users on a trunked system, a telephone–type busy signal or talk–prohibit tone sounds when an operator presses his PTT pushbutton while the system channels are busy.

2.4.2 Out of Range/Out of Service

A continuous tone sounds whenever the mobile operator cannot access the system for the following reasons:

- The mobile unit is out of range.
- The system is out of service.

2.4.3 Busy Queue/Call Back

Users requesting system access at a time when all voice channels are in use are put in a waiting queue and are served on a FIFO basis. When a channel be comes free, the system controller sends a call back tone to the first mobile unit in the waiting queue. The call back is a short series of beeping tones. This feature allows the operator receiving a busy indication to release his PTT pushbutton and wait for the call back signal rather than repeatedly pressing his PTT to attempt to access a system channel. These features operate only when the mobile unit is within range.

2.4.4 Talk–Permit Tone (Optional)

This optional feature sounds a brief (200 ms) series of tones whenever the operator keys up a voice channel. The talk–permit tones are identical to the call back tones and give the operator an indication that he has keyed up on a voice channel. Since this feature is a code–plug–implemented option, it can be provided on a select number of mobile units as desired.

2.4.5 Automatic Retry

Pressing the PTT initiates a channel request. The transmitter sends a burst of data to the central controller via the control channel. Since a single burst of data may not get through because of adverse signaling conditions or interference, the radio continuously sends channel requests until a request acknowledgement is received from the central controller or until four seconds have elapsed. These attempts continue even if the operator releases the PTT. The operator is not required to continually press the PTT to attempt to gain access to the system.

2.4.6 Recent User Priority

This feature gives users who have been assigned voice channels, priority over the other system users to ensure that a fleet engaged in a message transmission gets system access priority even if there is a short de lay between transmissions. This reduces the possibility of a channel not being available during an exchange of transmissions if a mobile operator is slow in responding.

2.4.7 Misdirected Mobile Protection

To ensure that no mobile unit from one fleet is accidentally assigned to a voice channel used by a different fleet, a subaudible data handshake is implemented in the system. Once a fleet is assigned to a voice channel, the repeater of the assigned channel keeps on sending an outbound stream of subaudible data containing the unique fleet or subfleet ID of the units using the channel. Should a unit from a different fleet or sub fleet be accidentally assigned to the same channel, the unit automatically reverts to the control channel since it does not have the proper ID. The audio of the errant mobile unit is muted and the transmitter is disabled for the fraction of a second that is actually spent on the wrong channel and thus could neither monitor nor key up on the wrong channel.

2.4.8 Continuous Assignment Updating

Once a voice channel is assigned to a fleet or sub fleet, the control channel keeps on transmitting the channel assignment for as long as that fleet is using the channel. This ensures that a mobile just coming into service is sent over to the appropriate channel to join the rest of his fleet. The assignment updating information is sent serially, and the total time that is required by the control channel to run through 19 assignments on a 20–channel system is approximately 500 milliseconds.

2.5 SYSTEM EXPANSION FEATURES

2.5.1 Adding Mobile Units

Motorola *SYNTOR X 9000E* Dual Operation Communications Systems are structured so that they allow the addition of mobile units without affecting the operation and privacy of mobile units currently using the system. Mobile units can be added to an existing user fleet or new users can be added without the need for any system changes (within the capacity limitations of the system).

2.5.2 Adding Channels

To increase the number of channels in *SYNTOR X 9000E* Dual Operation Systems, simply add the necessary base station and central controller equipment. It is not necessary to modify any mobile or control station to add an additional channel. The radios automatically accommodate the added voice channel.

2.6 SIGNALLING

Effective system operation has been achieved by binding the individual system blocks into a highly efficient coordinated entity by means of the data communications network. The majority of the data communications operations occurs over the system control channel. For example, requests for service are transferred from the system users to the central controller over his channel. Similarly, the control channel is used by the central controller to transfer channel assignment data or other control commands to the users.

All communications over the control channel use data words that are approximately 23 milliseconds long. These data words contain the information capacity required to address mobile units and to specify the action to be taken. The information bits comprising these words are appropriately assembled into a coded format that has sufficient error–correction and detection capabilities to ensure that highly reliable data communications are maintained in a two–way mobile radio environment. The encoded binary data is passed to the transmitter at a 3600–baud rate where it is filtered and impressed on the carrier by using direct baseband frequency modulation.

3. Conventional Features

SYNTOR X 9000E Dual Operation Communications Systems can operate in the conventional mode for compatibility with conventional repeater systems. *Digital Private–Line* (DPL) or carrier squelch (CSQ) signalling is available. DPL coding is automatically selected (when available) by the Mode selector.

Talkaround is available in the conventional (non–trunked) mode for mobile–to–mobile communications. In conventional repeater systems, the transmit and receive frequencies are different. When talkaround is selected, the transmitter frequency changes to the receiver frequency. All mobiles that need to communicate directly must select talkaround.

4. Radio Features

4.1 GENERAL

The *SYNTOR X 9000E* radios, including options, provide the following features:

- Microcomputer control
- Broad–band operation
- Frequency synthesis
- Improved transmitter and receiver performance
- Telephone interconnect option (trunking only)
- Programmable time–out timer
- System search and lock
- *Private–Line* and *Digital Private–Line* coded squelch
- Offset channel capability in the conventional mode (talkaround)
- Operator select *Channel Scan* operation
- Mode select *Channel Scan* operation
- *Private Conversation* call capability (trunking only)
- External alarms option
- Individual *Call Alert* page (trunking only)
- Emergency call and alarm option that provides channel access during emergency situations (*SMARTNET* trunking only)
- Dynamic reprogramming (regrouping) option that allows a dispatcher/supervisor to temporarily reassign individuals operating in separate subfleets to "regroup" into one communications subfleet (trunking only)
- Automatic multiple site switching (AMSS) option that provides an automatic handoff (switching) of the radio from one site to another site when the signal at the current site be comes too weak (*SMARTNET* trunking only)
- Wide operating temperature range (from –30°C to +60°C)
- Rugged construction that meets MIL–Spec–810D related to rain, dust, salty atmosphere, shock, and vibration
- All solid–state, compact, modular design that simplifies radio maintenance and troubleshooting

Some of these features are discussed in the following paragraphs. More detailed information about the features and options are included in the *SYNTOR X 9000E* Dual Operation Two–Way Radio Operator's Manual.

4.2 MICROCOMPUTER–CONTROLLED SYSTEM

Most major radio operations are controlled by an 8–bit microprocessor, a Read Only Memory (ROM) that contains the operating program, and associated support and control circuitry. This sophisticated microcomputer system is designed to simplify mobile operation.

4.3 BROAD BAND OPERATION

The *SYNTOR X 9000E* Dual Operation radio operates over a broad band of frequencies. Since frequencies can be added or changed without retuning or realigning the radios, the units can operate in different systems on widely separated frequencies.

4.4 FREQUENCY SYNTHESIS

Specific radio frequencies are generated electronically by using a frequency synthesizer rather than individual crystals or channel elements. This simplifies multiple–frequency operation since frequencies can be changed or added by reprogramming the radio. The frequency synthesizer reacts in milliseconds in priority mode scanning or polled data applications.

4.5 IMPROVED TRANSMITTER AND RECEIVER PERFORMANCE

SYNTOR X 9000E Dual Operation transmitters provide audio distortion rated at less than 2% (at 1000 Hz, 60% maximum deviation) and a frequency stability of +0.0002% of assigned center frequency (over an ambient temperature range of –40°C to +70°C). Spurious and harmonic emissions are rated at greater than 70 dB below carrier. Sensitivity of the receiver is rated at 0.25 microvolts (EIA SINAD), and spurious and image rejections is –10 dB. Frequency stability is identical to that of the transmitter.

4.6 PROGRAMMABLE TIME–OUT TIMER

The time–out timer causes the transmitter to stop transmission after the pre–programmed time interval. This

prevents repeater or channel tie–up because of prolonged keying of the transmitter.

4.7 SYSTEM SEARCH AND LOCK

The system Search and Lock feature allows the radio to automatically search through a pre–determined list of repeater systems if your mobile unit goes out of range of your "home" repeater. The radio then locks onto the system that is in the current coverage area. The repeater list can include trunked and/or conventional repeater systems.

4.8 *PRIVATE–LINE* OR *DIGITAL PRIVATE–LINE* CODED SQUELCH

The *Private–Line* or *Digital Private–Line* coded squelch is programmed as required. This feature allows mobile units to receive only the messages that use their individual system code. This reduces an operator's listening fatigue as well as the probability of missed or misunderstood messages.

4.9 REPEATER TALK–AROUND CAPABILITY

Repeater talk–around allows direct communication between two mobile units or between a mobile radio and a portable unit. Use the Mode select rocker or a separate pushbutton **[Dir]** to select talk–around operation.

4.10 *CHANNEL SCAN* OPERATION

The **[Scan]** button activates a pre–programmed set of *Channel Scan* parameters. This simplifies *Channel Scan* operation since it requires only one button to be used by an operator.

4.11 OPERATOR–SELECT *CHANNEL SCAN*

Operator–select *Channel Scan* allows you to manually select channels for scanning. This suits operators who prefer manual *Channel Scan* operation to a pre–programmed scan list.

4.12 *PRIVATE CONVERSATION* CALL

This feature allows the operator to place and receive private calls to another person such as a dispatcher/supervisor.

4.13 HORN AND LIGHTS ALARMS

This feature allows the operator to monitor a call when out of the vehicle via horn and/or lights indications.

4.14 INDIVIDUAL *CALL ALERT* PAGE

This feature allows the operator to send or receive a *Call Alert* page.

4.15 EMERGENCY CALL AND ALARM for *SMARTNET* MODELS ONLY

This feature allows the operator and/or dispatcher to have voice and/or control channel access during emergency situations.

4.16 DYNAMIC REPROGRAMMING for *SMARTNET* MODELS ONLY

This feature allows the dispatcher or shift super visor to temporarily reassign individuals operating in separate sub-fleets to reprogram or "regroup" into one communications subfleet.

4.17 AUTOMATIC MULTIPLE SWITCHING SITE (AMSS) for *SMARTNET* MODELS ONLY

This feature allows the operator to communicate over distances beyond the reach of a single site. In a system requiring wide area coverage, multiple trunked sites are used. The AMSS option automatically switches the radio from one site to a different site if the current site becomes too weak.

5. Electrical Characteristics

The basic *SYNTOR X 9000E* Dual Operation radios come fully equipped for operation. The units operate from a negative–ground, 12–volt DC source. A standard control unit, speaker, microphone with a hang–up bracket, antenna with a 14–foot cable, and a 17–foot negative–ground cable kit are included.

5.1 CIRCUIT BLOCKS

The radio is grouped into the following blocks: (a) control unit, (b) personality board, (c) trunked controller board, (d) common circuits board, (e) 35–watt or 15–watt power amplifier, (f) radio frequency (RF) board, and (g) internal casting. The internal casting comprises a voltage–controlled oscillator (VCO), preamplifier, mixer, six–pole filter, two–pole and three–pole filter, and a buffer.

5.2 FUNCTIONAL DESCRIPTION

The radio can be functionally divided into five parts: (a) microcomputer, (b) control unit, (c) frequency synthesizer, (d) receiver, and (e) transmitter. The microcomputer circuits are contained on the personality board. The frequency synthesizer circuits are contained on the common circuits board, RF board, and internal casting. The receiver circuits are contained on the personality board, common circuits board, RF board, and internal casting. The transmitter circuits are contained on the common circuits board and power amplifier. A brief description of each functional segment is provided below; further description is provided in the section associated with the circuit in question.

5.2.1 Microcomputer

The personality board contains the microcomputer system and code plug. The microcomputer consists of an eight–bit microprocessor, a read only memory that contains the operating program, and associated supporting and control circuitry. The microcomputer controls all operations of the radio from lighting the control panel indicators to frequency selection.

5.2.2 Control Unit

The control unit has two circuit boards. One is the controller board and the other is the display board. The display

board contains switch contacts and an 11 character, 14 segment display. The display is driven by a driver that receives serial data from the microprocessor on the control board.

The microprocessor contains the operating software. The EEPROM contains re–programmable customer information.

The display board contains the following:

- Vacuum fluorescent (VF) display,
- VF display driver,
- Backlight and indicator LEDs,
- Switch contacts.

The controller board contains the following:

- Microprocessor and EEPROM,
- Serial data link receiver and transmitter,
- +5 volt regulator,
- Watchdog timer,
- Vehicle interface ports (VIPs).

5.2.3 Frequency Synthesizer

The frequency synthesizer is used to generate the first receive injection frequency and transmitter carrier. In the receive mode, the synthesizer locks on a frequency that is 53.9 MHz (first I–F) lower than the desired receive frequency. In the transmit mode, the synthesizer locks on the transmit output frequency.

The synthesizer employs a phase–locked loop (PLL) that operates at half the desired output frequency and consists of: a 14.4 MHz reference oscillator, a low–noise voltage controlled oscillator (VCO), a high–speed programmable divide–by–3 or 4 variable modulus prescaler, a lower–speed programmable divider, a sample–and–hold phase detector, and a loop adaptive filter. It also uses a buffer doubler/splitter that doubles the VCO output frequency for use by the radio.

The 14.4–MHz reference oscillator output is applied, via an injection tripler, to the second mixer of the receiver, where it serves as the low–side second injection frequency. Microphone audio from the personality board is applied to the IDC (instantaneous deviation control) circuitry located on the common circuits board. The IDC circuits process the audio to ensure that the proper level of audio drive is supplied to the frequency synthesizer.

5.2.4 Receiver

The incoming RF signals are applied to the RF preamplifier via the antenna relay and a two–pole preselector filter. The preamplifier output passes through a six–pole preselector filter and is then applied to the first mixer stage. The selectivity of the two filters is such that it prevents high–level, out–of–band signals from degrading receiver performance.

The frequency synthesizer RF output is doubled and then applied to the first mixer via a three–pole injection filter. The first mixer generates an I–F (intermediate frequency) of 53.9 MHz that is sufficiently amplified by two amplifiers so that it is able to drive the second mixer. The second mixer uses the 53.9 MHz signal and a 43.2 MHz signal from an injection tripler to generate a 10.7 MHz I–F. After amplification, the 10.7 MHz signal passes to the limiter/detector stage.

The receiver uses two four–pole crystal filters that substantially attenuate signals outside the predetermined receiver bandpass range. The detected audio is fed to audio amplifiers on the personality board. When the microcomputer enables the audio enable switch, the audio is amplified and applied to the speaker.

5.2.5 Transmitter

The RF output generated by the frequency synthesizer at the required transmit frequency is applied to the controlled stage of the intermediate power amplifier (IPA) of the transmitter. The RF signal passes from the IPA to a power amplifier, via a coaxial cable, and is applied to the predriver stage. The predriver stage is followed by a drive stage, and both stages provide sufficient output to drive the final power amplifier. The predriver and driver stages are mounted on separate microstrip assemblies.

The transmitter is provided with a temperature–sensing circuit that protects the final power amplifier against damaging high temperatures. The temperature–sensing circuit works in conjunction with the power control circuit located on the common circuits board. The power control circuits provide power leveling and protection to the final power amplifier stage of the transmitter. These circuits receive forward and reflected power data from a directional coupler that is electrically located between the final power amplifier stage and the harmonic filter assembly.

The transmitter IPA receives a control voltage that is controlled by the forward power, VSWR, and final PA temperature data. When the control voltage changes, it causes a change in the gain of the first stage of the IPA, and, hence, in the RF drive level to the final power amplifier.

6. Primary Power Source

SYNTOR X 9000E Dual Operation radios are designed to operate from a negative–ground, 12–volt DC source. A built–in floating ground is used by the radios.

7. Physical Characteristics

The *SYNTOR X 9000E* Dual Operation radio electronic circuits are enclosed in a rugged low–profile housing. One end of the housing contains the antenna connector, lock–switch, main cable connector, and handle. The other end contains the heatsink fins that provide cooling for the power amplifier circuits. The various radio circuits have been provided with the pro per isolation by using partitions and shielding covers. The radios employ an easy–to–snap–on top cover and a bottom cover that is secured to the radio by means of four screws. A mounting tray is also provided with the radios.

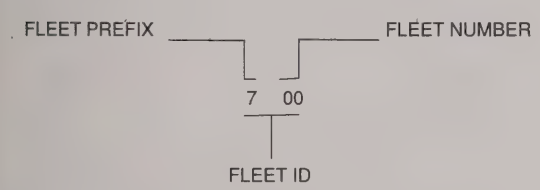
Table 1. Size Code Field Size Table

SIZE CODE			NUMBER OF BITS PER FIELD			
LETTER	DECIMAL	BINARY	FLEET PREFIX	FLEET NUMBER	PERSONALITY ID	POOL ID
A	0	00000	3	7	4	2
B	1	00001	3	4	6	3
C	2	00010	3	3	7	3
D	3	00011	3	0	9	4
E	4	00100	3	6	5	2
F	5	00101	3	5	5	3
G	6	00110	3	5	6	2
H	7	00111	3	4	7	2
I	8	01000	3	3	8	2
J	9	01001	3	2	8	3
K	10	01010	3	1	8	4
M	11	01011	2	0	10	4
O	14	01110	1	0	11	4
Q	16	10000	0	012	4	

8. Calculating 6–Digit Personality (Individual) ID's

8.1 GENERAL

Each radio has a unique identification consisting of a fleet ID, personality ID, and a size code letter. For Unlimited *Private Conversation* or Unlimited *Call Alert* options to operate, each radio has a six–digit decimal number that is derived from a binary number containing a FLEET PREFIX field, a FLEET NUMBER field, a PERSONALITY ID field, and a SIZE CODE field. The fleet prefix and the fleet number come from the fleet ID as shown in the following:



Fleet and the personality ID numbers in the Trunked Code Management System (TCMS) data base are in hexadecimal. Follow the steps below to determine the six–digit decimal number corresponding to any given radio identification for *Private Conversation II* or Unlimited *Call Alert*.

(1) Find the size code in Table 1 for the given identification. The converted five–bit long binary number represents the size code field.

(2) The size code determines the number of bits in each field. For the given identification size code, use Table 1 to determine how many bits are in each of the three other fields.

(3) Represent the fleet prefix number as a three–bit long binary number. LEFT justify this binary number (Table 2) in the number of bits listed in Table 1 for the fleet prefix field. This binary number is the fleet prefix field.

Note

Bits which overflow the fleet prefix field on the right should be discarded (size code letters M, O, and Q).

(4) Represent the fleet number as a binary number. RIGHT justify this binary number in the number of bits listed in Table 1 for the fleet field. This binary number is the fleet number field.

(5) Convert the personality ID to a binary number. RIGHT justify this binary number in the number of bits listed in Table 1 for the personality ID field. This binary number is the personality ID field.

(6) Beginning from the left, combine the fleet prefix, fleet number and personality ID fields into one binary number. Add enough leading 0's (zeros) to make the binary number 14 bits long. If the number is already 14 bits long, there is no need to add to it.

(7) Append the binary number found in step 6 to the right of the binary size code field to form a 19–bit long binary number.

(8) Convert the number found in step 7 to its decimal equivalent. This decimal number is the six–digit Unlimited *Private Conversation II*/Unlimited *Call Alert* ID.

Table 2. Hexadecimal and Binary Equivalents

HEXADECIMAL	BINARY
0	00000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
A	01010
B	01011
C	01100
D	01101
E	01110
F	01111

8.2 EXAMPLE 1

A radio is assigned the following identification (all values shown are hexadecimal except size code which is decimal):

Fleet prefix number 4
Fleet number ..... none
Personality ID 2F0
Size code number ..... 14(0)

(1) This radio's size code, 14, is expressed as the five–digit binary number 01110. Therefore, the size code field is 01110.

(2) According to Table 1, size code 14 has the following bits per field:

Fleet Prefix ..... One
Fleet Number ..... None
Personality ID ..... Eleven

(3) The fleet prefix number of this radio 4 is binary 100. Left justifying this into one bit gives a fleet prefix field of one. (The two rightmost 0's [zeros] are dropped when 100 is left justified into a one–bit long field.)

(4) There is no fleet number field for size code 14.

(5) The personality ID of this radio is 2F0, which is binary 001011110000. Right justifying this into 11 bits gives a personality field of 0101110000.

(6) Beginning from the left, combine the fleet prefix, fleet number, and personality ID into one large binary number:

Fleet Prefix	and	Fleet Number	and	Personality ID	equals	Binary Number
1	+	(none)	+	0101111000	=	101011110000

Since this number is only 12 bits long, add two zeros to the left:

00101011110000

(7) From Step 1, merge the size code with the binary number found in Step 6:

Size Code	and	binary number	equal binary personality ID
01110	+	00101011110000	= 0111000101011110000

(8) Convert the binary number to its decimal equivalent (see Table 3). The Unlimited *Private Conversation II/Call Alert* six–digit decimal identification number for the radio in this example is 232176.

8.3 EXAMPLE 2

A radio is assigned the following identification (all values shown are hexadecimal except size code which is decimal):

Fleet prefix number 5
Fleet number 0B
Personality ID 01F
Size code number ..... 4(E)

(1) This radio's size code, 4, is expressed as the five–digit binary number 00100. Therefore, the size code field is 00100.

(2) According to Table 1, size code 4 has the following bits per field:

Fleet Prefix ..... Three
Fleet Number ..... Six
Personality ID ..... Five

(3) The fleet prefix number of this radio 5, which is binary 101. Left justifying this into three bits gives a fleet prefix field of 101.

(4) The fleet number of this radio is 0B, which is binary 00001011. Right justifying this into six bits gives a fleet number of 001011.

(5) The personality ID of this radio is 01F, which is binary 000000011111. Right justifying this into five bits gives a personality field of 11111.

(6) Beginning from the left, combine the fleet prefix, fleet number, and personality ID into one large binary number:

Fleet Prefix	and	Fleet Number	and	Personality ID	equals	Binary Number
101	+	001011	+	11111	=	10100101111111

Since this number is already 14 bits long, do nothing further with it.

(7) From step 1, merge the size code with the binary number found in step 6:

Size Code	and	binary number	equal	binary personality ID
00100	+	10100101111111	=	0010010100101111111

(8) Convert the binary number to its decimal equivalent (see Table 3). Right justifying this into six digits gives an Unlimited Call ID of 076159.

8.4 CREATION OF SIX–DIGIT INDIVIDUAL ID'S FOR *PRIVATE CONVERSATION I* ID'S

Follow the steps below to determine the six–digit decimal number corresponding to any given radio identification for *Private Conversation I*.

(1) In Table 1, find the size code for the given identification.

(2) The number of bits in each field depends on the size code of the given identification. See Table 1 to determine how many bits are in each of the four fields for a given size code.

(3) Represent the fleet prefix number as a three–bit long binary number. LEFT justify this binary number (Table 2) in the number of bits listed in Table 1 for the fleet prefix field. This binary number is the fleet prefix field. Note Bits which overflow the fleet prefix field on the right should be discarded (size code letters M, O, and Q).

(4) Represent the fleet number as a binary number. RIGHT justify this binary number in the number of bits listed in Table 1 for the fleet field. This binary number is the fleet number field.

(5) Represent the POOL ID's as a binary number. Right justify this binary number in the number of bits listed in Table 1 for the POOL ID field.

(6) Convert the personality ID to a binary number. RIGHT justify this binary number in the number of bits listed in Table 1 for the personality ID field. This binary number is the personality ID field.

(7) Beginning from the left, combine the fleet prefix, fleet number, pool ID and personality ID. This number will always be 16 bits long.

(8) Convert the number found in step 7 to its decimal equivalent. Then add decimal number 600000 to the decimal number. This leading 6 will show that the six–digit ID is an Unlimited *Private Conversation I* ID.

8.5 EXAMPLE 3

A radio is assigned the following identification (all values shown are hexadecimal except size code which is decimal):

Fleet prefix number 4
Fleet number 05
Personality ID 001
Size code number ..... 2(C)
Supervisor Pool ID 01

(1) This radio's size code, 2, is expressed as the five–digit binary number 00010. Therefore, the size code field is 00100.

(2) According to Table 1, size code 4 has the following bits per field:

Fleet Prefix ..... Three
Fleet Number ..... Three
Personality ID ..... Seven
Pool ID ..... Three

		Example 1		Example 2		Example 3	
Bit Position	**Bit Weighting**	**Binary Value**	**Decimal Value**	**Binary Value**	**Decimal Value**	**Binary Value**	**Decimal Value**
MSB 19	262144	0	0	0	0	–	–
18	131072	1	131072	0	0	–	–
17	65536	1	65536	1	65536	–	–
16	32768	1	32768	0	0	1	32768
15	16384	0	0	0	0	0	0
14	8192	0	0	1	8192	0	0
13	4096	0	0	0	0	1	4096
12	2048	1	2048	1	2048	0	0
11	1024	0	0	0	0	1	1024
10	512	1	512	0	0	0	0
9	256	0	0	1	256	0	0
8	128	1	128	0	0	1	128
7	64	1	64	1	64	0	0
6	32	1	32	1	32	0	0
5	16	1	16	1	16	0	0
4	8	0	0	1	8	0	0
3	4	0	0	1	4	0	0
2	2	0	0	1	2	0	0
1	1	0	0	1	1	1	1
Decimal Value:			232176		76159		38017

(3) From Table 2, the fleet prefix number 4 is binary 100; left justify for a fleet prefix of 100.

(4) This radio's fleet number 05 is binary 00000101; right justify it to a three–bit binary number of 101.

(5) The supervisor pool ID is 01, represented as binary 00000001; right justify to a three–bit binary number of 001.

(6) The personality number of this radio, 001, is binary 000000000001; right justify to a seven–bit binary number of 0000001.

(7) Beginning from the left, combine the fleet prefix, fleet number, pool ID and personality ID. This number is always 16 bits long.

Fleet Prefix	and	Fleet Number	and	Pool ID	and	Personality ID	equals	Binary Number
100	+	101	+	001	+	0000001	=	1001010010000001

(8) Convert the binary number to its decimal equivalent (see Table 3). For this example, the decimal number is equal to 38017. Because this number is never larger than 16 bits, the decimal number can not be larger than five digits. Complete the six–digit ID by adding decimal number 600000 to the five–digit decimal number found in Table 3– 638017; the leading "6" in the number identifies it as an Unlimited *Private Conversation I* ID.

9. Radio Identification Label

The radio identification label identifies information needed for servicing the radio. Each field of information is explained by the following. The numbered items in Figure 2, cover TRUNKED USER MODE INFORMATION, CONVENTIONAL MODE INFORMATION, SYSTEM INFORMATION, and MULTIPLE PL INFORMATION. Do not destroy this information. Figure 2 illustrates a typical label.

9.1 TRUNKED MODE INFORMATION

The radio's trunked system is defined below. The numbers in parenthesis, e.g. (1) are keyed to the call outs in Figure 2.

(1) DATE: this field identifies the date the trunking information was printed.

(2) SERIAL NUMBER (SN): this field identifies the radio's serial number.

(3) MODEL: this field identifies the radio's model number.

(4) FACTORY ORDER NUMBER (FO): this field identifies the factory sales order number.

(5) TRUNK: this area indicates the trunked mode information.

(6) MODE: this field identifies the specific trunked user mode number.

(7) PERS: this field indicates the personality number referred to below in personality information.

(8) SUBF: this field identifies the subfleet value for the specific mode number.

(9) FAILSOFT: this field identifies the failsoft frequency in MHZ for the specific user mode; for AMSS systems, refer to the failsoft frequencies listed under the personality information.

9.2 CONVENTIONAL MODE INFORMATION

(10) CONV: this area indicates the conventional mode information.

(11) MODE: this field identifies the specific conventional user mode number.

(12) RX: this field identifies the receive channel frequency in MHZ.

(13) TX: this field identifies the transmit channel frequency in MHZ.

(14) RX CODE: this field identifies the receiver PL, DPL or CSQ tone assignment.

(15) TX CODE: this field identifies the transmitter PL, DPL or CSQ tone assignment.

(16) T/A: this field identifies the transmit talk around frequency in MHZ.

(17) TOT: this field identifies the time out timer value.

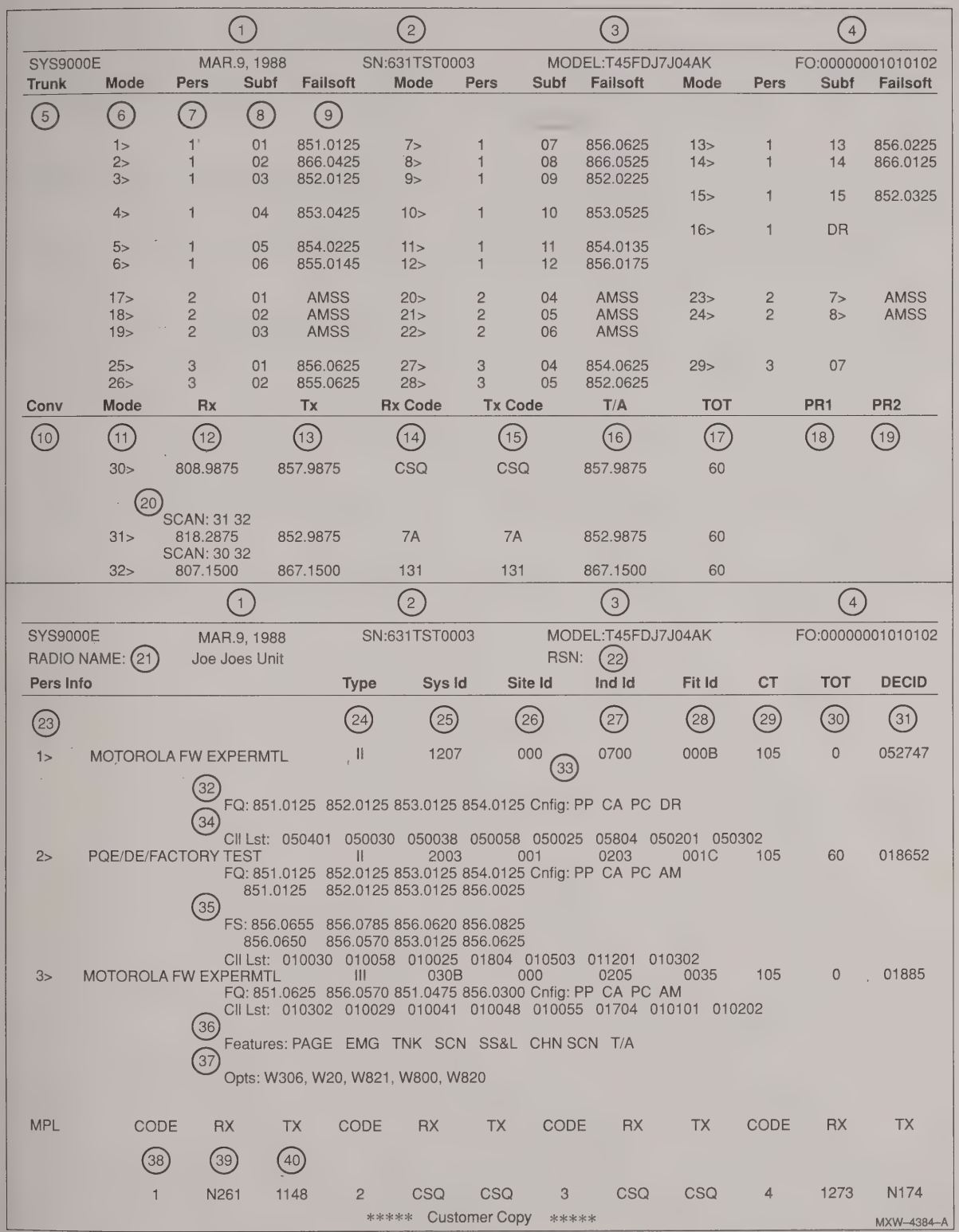
(18) PR1:this field identifies the first priority scan selection.

(19) PR2: this field identifies the second priority scan selection.

(20) SCAN: this field identifies the modes scan list.

(21) RADIO NAME: this field identifies the radio name assigned at time of order processing.

(22) RADIO SERIAL NUMBER (RSN): this field identifies the original radio serial number when replacement codeplugs have been ordered.



SYS9000E MAR.9, 1988 SN:631TST0003 MODEL:T45FDJ7J04AK FO:00000001010102

Trunk	Mode	Pers	Subf	Failsoft	Mode	Pers	Subf	Failsoft	Mode	Pers	Subf	Failsoft
	1>	1	01	851.0125	7>	1	07	856.0625	13>	1	13	856.0225
	2>	1	02	866.0425	8>	1	08	866.0525	14>	1	14	866.0125
	3>	1	03	852.0125	9>	1	09	852.0225				
									15>	1	15	852.0325
	4>	1	04	853.0425	10>	1	10	853.0525				
									16>	1	DR	
	5>	1	05	854.0225	11>	1	11	854.0135				
	6>	1	06	855.0145	12>	1	12	856.0175				
	17>	2	01	AMSS	20>	2	04	AMSS	23>	2	7>	AMSS
	18>	2	02	AMSS	21>	2	05	AMSS	24>	2	8>	AMSS
	19>	2	03	AMSS	22>	2	06	AMSS				
	25>	3	01	856.0625	27>	3	04	854.0625	29>	3	07	
	26>	3	02	855.0625	28>	3	05	852.0625				

Conv	Mode	Rx	Tx	Rx Code	Tx Code	T/A	TOT	PR1	PR2
	30>	808.9875	857.9875	CSQ	CSQ	857.9875	60		
		SCAN: 31 32							
	31>	818.2875	852.9875	7A	7A	852.9875	60		
		SCAN: 30 32							
	32>	807.1500	867.1500	131	131	867.1500	60		

SYS9000E MAR.9, 1988 SN:631TST0003 MODEL:T45FDJ7J04AK FO:00000001010102

RADIO NAME: Joe Joes Unit RSN:

Pers Info	Type	Sys Id	Site Id	Ind Id	Fit Id	CT	TOT	DECID
1> MOTOROLA FW EXPERMTL	II	1207	000	0700	000B	105	0	052747
FQ: 851.0125 852.0125 853.0125 854.0125 Cnfig: PP CA PC DR								
Cll Lst: 050401 050030 050038 050058 050025 05804 050201 050302								
2> PQE/DE/FACTORY TEST	II	2003	001	0203	001C	105	60	018652
FQ: 851.0125 852.0125 853.0125 854.0125 Cnfig: PP CA PC AM								
851.0125 852.0125 853.0125 856.0025								
FS: 856.0655 856.0785 856.0620 856.0825								
856.0650 856.0570 853.0125 856.0625								
Cll Lst: 010030 010058 010025 01804 010503 011201 010302								
3> MOTOROLA FW EXPERMTL	III	030B	000	0205	0035	105	0	01885
FQ: 851.0625 856.0570 851.0475 856.0300 Cnfig: PP CA PC AM								
Cll Lst: 010302 010029 010041 010048 010055 01704 010101 010202								
Features: PAGE EMG TNK SCN SS&L CHN SCN T/A								
Opts: W306, W20, W821, W800, W820								

MPL	CODE	RX	TX	CODE	RX	TX	CODE	RX	TX	CODE	RX	TX
	1	N261	1148	2	CSQ	CSQ	3	CSQ	CSQ	4	1273	N174

***** Customer Copy *****

MXW–4384–A

Figure 2. Radio Identification

9.3 SYSTEM INFORMATION

(23) PERS INFO: this field indicates the trunked personality information referenced in the trunked user mode.

(24) TYPE: Defines the type of trunking protocol used by the system.

(25) SYS ID: this field identifies the trunking system ID information in hexadecimal.

(26) SITE ID: this information identifies the site ID for AMSS wide area coverage systems; single site systems will always be 000.

(27) IND ID: this information identifies the individual unit ID information in hexadecimal.

(28) FLT ID: this information identifies the fleet ID information in hexadecimal.

(29) CT: this field identifies the connect tone frequency in Hz.

(30) TOT: this field identifies the time out timer in seconds.

(31) DECID: this field identifies the individual six digit identification number used for *Private Conversation II*/*Call Alert*.

(32) FQ: this field identifies the system control channel frequencies in MHz.

(33) CONFIG: this field identifies the presence of available radio options as follows; PI – Phone Interconnect, CA – *Call Alert*, PC – *Private Conversation*, PT – Push To Talk ID, EC – Emergency Call, EA – Emergency Alarm, SM – Status/Message, DR – Dynamic Regrouping, AM – Automatic Multiple Site Switching, TS – Trunking Scan

(34) CLL: this field identifies the call list information (in six digit decimal ID format) used for *Private Conversation* or *Call Alert*.

(35) FS: this field identifies the AMSS failsoft frequencies in MHz.

(36) FEATURES: this field identifies the features which are included with the radio model.

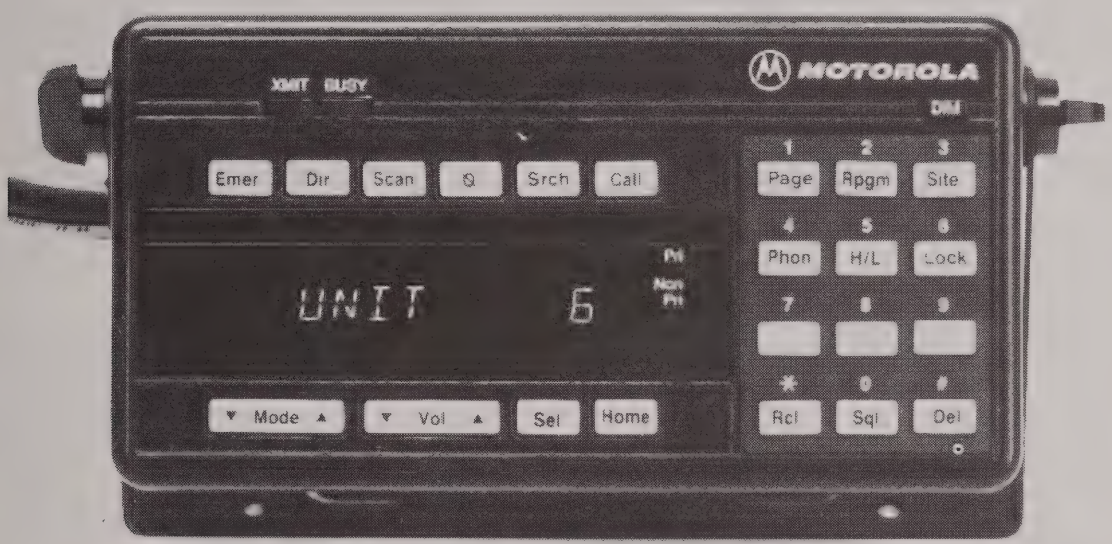
(37) OPTS: this field indicates which options were ordered with the radio.

9.4 MULTIPLE PL INFORMATION

(38) CODE: this field identifies the MPL code number.

(39) RX: this field identifies the receiver PL, DPL or CSQ tone assignment.

(40) TX: this field identifies the transmitter PL, DPL or CSQ tone assignment.



GPW–4141–A

Figure 1. SYNTOR X 9000E *Control Unit*

1. General

The *SYNTOR X 9000E* Dual Operation mobile units consist of:

- Remote mountable radio,
- Dual operation control unit,
- Microphone,
- Speaker,
- Antenna,
- Interconnecting cable.

The dual operation mobile units are supplied with control units that meet the basic requirements for trunking and conventional operation.

The *SYNTOR X 9000E* Control Unit has the following controls and indicators.

- Power on/off slide switch.
- DIM button for display brightness.
- Rocker switch volume control.
- Rocker and keypad mode–select control.
- Channel BUSY indicator light.
- Transmit indicator light.
- Priority channel indicator light.
- Non–priority channel indicator light.
- Squelch button to set volume and monitor channel activity.
- Option control buttons and indicators.

2. Radio Operation

2.1 ALERT TONES

The following alert tones aid the operator by indicating unique system conditions.

System Busy– Telephone type busy signal, heard when pressing the microphone PTT (push–to–talk) button, indicates that you cannot transmit because all radio channels in the system are in use.

Automatic Call Back– Beeps heard when radio is in receive mode indicates that a channel is now available for your previously requested transmission.

Talk Prohibit– Continuous low–pitched tone, heard when the microphone PTT button is pressed, indicates that you are out of range of the trunked radio system, or that the system is out of service.

Failsoft– A high–pitched beep heard every 10 seconds in an unmuted receive mode indicates failure of the System Central Controller. The radio reverts from trunked operation to a system similar to conventional radio repeater operation.

Volume Set– A tone heard to ensure desired volume level before calls are actually received.

Illegal Mode– A low pitched tone that indicates an invalid button position has been selected.

Selective Call– Two high pitched beeps indicate that a private call has been received.

Individual Page– High pitched beep every five seconds indicates that the radio is being paged.

Talk Permit (optional)– A short tone, heard when pressing the microphone PTT button, verifies that the system is accepting your transmission.

Time–Out Timer alert (optional)– A low pitched continuous tone that indicates your present transmission will soon be disabled.

Phone Off–Hook (optional)– Low pitched continuous tone that indicates your radio is in the Telephone Interconnect mode of operation and cannot receive fleet or subfleet calls.

Telephone Interconnect Busy (optional)– Four telephone type busy tones, heard when the telephone button is pressed, indicates the interconnect repeater is busy. Followed automatically by a dial tone when interconnect repeater becomes available, as long as the operator remains in the telephone interconnect mode.

Central Acknowledge (optional)– One high pitched tone indicates that an Individual *Call Alert* or Emergency Alarm has been received by the System Central Controller.

Mobile Unit Acknowledge (optional)– Four high pitched tones indicate the Individual Page has been received by the intended unit, or the Emergency Alarm or Status/Message has been received by the intended dispatcher.

Dynamic Reprogramming (optional)– A unique chirp indicates when a dynamic ID has been received. If the user has not selected the "reprogrammed" subfleet, this chirp is heard when the PTT button is pressed.

2.2 TO RECEIVE

Perform the following steps to adjust your radio for operation.

(1) Slide the power ON/OFF switch to the left until it locks in position. The Control Unit display comes on showing "SELF CHECK" for two to three seconds, then displays the current selected mode. If the radio system fails its diagnostics on power up, an error code displays. See the Maintenance and Troubleshooting section of this manual. If the failure is critical, the radio ceases operation.

(2) Select a mode on which to operate.

(3) For modes with PL/DPL, turn squelch on.

(4) Adjust the volume level to a comfortable listening level during an incoming signal.

2.3 TO TRANSMIT

With the radio switched on, perform the following steps to transmit on your radio system.

Note

If the radio is equipped with Dynamic Regrouping option, one mode position is used for the Dynamic mode operation. Thus, the total number of modes (subfleets) available may be one less than is offered.

Note

Radio systems equipped with the System/Subfleet control unit option have different legends on the rocker switches. Use the **[Subfleet]** rocker when the manual refers to the **[Mode]** rocker.

(1) Select the desired talk group with the **[Mode]** rocker.

(2) Lift microphone off–hook. Press and hold the microphone PTT button.

(3) When the red transmit indicator lights, hold the microphone about two inches from your lips, speak slowly into the microphone in a normal voice, state your FCC call sign, and proceed with your message. Release the microphone PTT button to receive.

(4) If you hear a telephone–type busy signal, all channels are in use. Release the microphone PTT button and wait for the Call Back tone.

(5) If you hear a continuous tone, you are out of range of the system. The red transmit light flashes as the radio tries to

access the system. Release the microphone PTT button and try again after the vehicle returns within range of the system.

3. Mode Select

Use the **[Mode]** rocker switch to scroll forward and backward through the list of programmed modes. Modes can be field programmed with user defined names. Mode names are allowed 11 characters, it is suggested however, to allow three digits for a mode number and eight digits for the mode name to provide both name and numeric mode association.

On units equipped with the Zone/Mode or System/Subfleet control unit option, the individual user modes (or subfleets) can be assigned into groupings of zones (or systems). This is sometimes necessary when the radio is configured with a large number of talk groups.

Note

If the radio is equipped with Dynamic Regrouping option, one mode position is used for the Dynamic mode operation. Thus, the total number of modes (subfleets) available may be one less than is offered.

4. *Channel Scan*

The *Channel Scan* feature allows you to scan a previously defined list of trunked or conventional modes for activity. If no activity exists, the display shows your selected mode. When a scanned mode becomes active, the display shows the active mode, the appropriate priority (PRI) or non–priority (NON–PRI) indicator lights, and *Channel Scan* unmutes the radio.

Note

Trunking priority scan (priority monitor) is not available in *Privacy Plus* radios.

Press the **[Scan]** button to turn *Channel Scan* on or off. With scan on, the previously selected scan list enables, and the red indicator lights.

4.1 MODE SLAVED SCAN

On mode select scan radios, the scan list is pre–programmed and may not be modified. When scan activity occurs, the currently active mode number or name displays, the appropriate priority (PRI) or non–priority (NON–PRI) indicator lights and the radio unmutes.

Press the **[Scan]** button to turn *Channel Scan* on and off. The internal scan list is enabled for the selected mode when scan is on, and the *Channel Scan* indicator lights.

4.2 OPERATOR SELECTABLE SCAN

On models with Operator Selectable Scan, you may review the scan list and/or modify it by holding the **[Scan]** button until an alert tone (beep) sounds and the red indicator blinks. Enter your new scan list by using the **[Mode]** rocker to locate the mode name, or by selecting a mode number with the keypad. Once the desired mode displays, press the **[Sel]** button to add it to the list.

Press the **[Sel]** button once to add the new mode as a non–priority list member (NON–PRI lights), press **[Sel]** a second time to add the new mode as a second priority list member (PRI lights), or press **[Sel]** three times to add the new mode as a first priority list member (PRI blinks).

You may remove modes from your list or review your scan list. Press the **[Del]** button to remove modes from your scan list. Review the scan list by pressing the **[Rcl]** button.

Press the **[Home]** button to exit the Scan list entry mode and return to normal operation.

4.3 DYNAMIC PRIORITIES

The Dynamic Priority feature allows you to modify the priority of a scanned mode using the **[Sel]** button. Press **[Sel]** during mode activity to temporarily assign a NON–PRI mode to second (PRI lights) priority.

Restore the scan list to the normal priority assignments by turning Scan off and on, changing modes, pressing **[Rcl]**, or turning the radio off and on.

4.4 NUISANCE DELETE

A NON–PRI mode in the scan list that becomes too active or you no longer desire may be temporarily deleted by the **[Del]** button during mode activity.

Press the **[Rcl]** button, turn Scan off and on, change modes, or turn the radio off and on to restore a temporarily deleted mode to your scan list.

Priority modes may not be temporarily deleted.

4.5 TALK BACK SCAN

Talk Back Scan allows you to transmit on the last active received mode, regardless of the selected mode on the control unit.

5. Selective Call

The Selective Call feature allows you to place and receive private calls with specific units in the trunking system.

You select a target unit from a pre–stored list of up to nine frequently called units. If your unit is equipped with Unlimited Call, you may select from the pre–stored list or use the keypad to call any properly equipped unit in the system.

5.1 INITIATING A SELECTIVE CALL

To initiate a Selective Call, you press the **[Call]** button. An alert tone sounds and the red indicator light blinks. The display shows the last ID called. With Unlimited Call capability, you may use the keypad to enter the desired 6 digit ID or use the **[Mode]** rocker to scroll through the pre–stored list of names and their associated ID numbers.

After completing the Selective Call, press the **[Home]** button to return to normal radio operation.

5.2 TO RECEIVE A SELECTIVE CALL

When you receive a Selective Call you hear two alert tones and the display shows "CALL".

Note

If the radio is equipped with the External Alarms (Horn and Lights) option, see the External Alarms section of this manual.

Press the **[Call]** button to answer the call. An alert tone sounds and the red indicator light blinks. The display changes to "ID–RCVD". Press PTT to respond to the call.

After you complete the Selective Call, press the **[Home]** button to return the radio to normal operation.

5.3 STORING CALL ID'S

Press the **[Call]** button, an alert tone sounds, the indicator blinks, and the display shows the last ID called. Use the **[Mode]** rocker to scroll to "STORE ID" and press the **[Sel]** button. The display changes to the programmed Call names (Call names are field programmable). If the Call name is left on the display for more than two seconds, the display changes to the ID currently stored at that location. Left alone, the display alternates, between name and ID, every two seconds. This allows you to review the ID before changing it. When the desired memory location is displayed, press the buttons on the keypad to enter the ID to be stored.

After the ID has been entered, press the **[Sel]** button to store it in memory and continue or press the **[Home]** button to store it and exit the Call storage mode.

6. Individual Page

Individual Page Encode/Decode allows you to selectively alert specific units in the trunking system.

You may select a target unit from a pre–stored list of up to nine frequently paged units. If your unit is equipped with unlimited Page, you may select from the pre–stored list or use the keypad to page any properly equipped unit in the system.

6.1 INITIATING AN INDIVIDUAL PAGE

Press the **[Page]** button to initiate an Individual Page. An alert tone sounds and the display shows the last ID paged. With Unlimited Call capability, you may use the keypad to enter the desired 6 digit ID or use the **[Mode]** rocker to scroll through the pre–stored list of names and their associated ID numbers.

Once the desired ID number is selected, the page is initiated by pressing **[Sel]**. The display shows "PLEASE WAIT" while the page is being processed.

If the mobile unit being paged sends a Unit Acknowledge to your paging unit, your display shows "ID PAGED" and you hear four additional alert tones. The radio immediately exits Page and your radio returns to the normal operation. If the acknowledgement is not received within three to five seconds after the page has been transmitted, the display shows "PAGE NO ACK".

A receiving unit may not receive a page for one of the following reasons:

- Unit is off,
- Unit is engaged in a conversation on a voice channel,
- Unit is out of range.

After completing the Page, press the **[Home]** button to return the radio to normal operation.

6.2 TO RECEIVE AN INDIVIDUAL PAGE

Note

If the radio is equipped with the External Alarms (Horn and Lights) option, see the External Alarms section of this manual.

When an Individual Page is received, you hear four alert tones and the display flashes "PAGE". This sequence is repeated periodically until you acknowledge the page by pressing PTT.

6.3 STORING PAGE ID'S

Press the **[Page]** button, an alert tone sounds and the display shows the last ID paged. Use the **[Mode]** rocker to scroll to "STORE ID" and press the **[Sel]** button. The display changes to the programmed Page names (Page names are field programmable). If the Page name is left on the display for more than two seconds, the display changes to the ID currently stored at that location. Left alone, the display alternates, between name and ID, every two seconds. This allows you to review the ID before changing it.

When the desired memory location displays, press the buttons on the keypad to enter the ID to be stored.

After the ID has been entered, press the **[Sel]** button to store it in memory and continue or press the **[Home]** button to store it and exit the Page storage mode.

7. Emergency Call And Alarm *SMARTNET* Models Only

The Emergency Call (Trunking operation only) and Alarm features allow you to have priority channel access during emergency situations.

Depending on the customer selection at the time of ordering, any one of several differing configurations are available. These include;

- Emergency Call (only)– occurs on a voice channel,
- Emergency Alarm (only)– occurs on a control channel,
- Silent Emergency Alarm,
- Emergency Call/Alarm combination.

7.1 EMERGENCY CALL

Press the **[Emer]** button to activate the Emergency Call feature. The indicator lights and the display flashes "EMERGENCY".

Note

For units with the Silent Emergency option, see paragraph 7.3.

Note

If your radio is equipped with an external emergency switch, it performs the same function as the **[Emer]** button.

Press the microphone PTT to initiate the Emergency Call as defined by the System Manager (i.e. Ruthless Preemption, Top of Queue, etc.)

After completing the Emergency Call, press and hold the **[Emer]** button until an alert tone sounds and the indicator goes off.

7.2 EMERGENCY ALARM

Press the **[Emer]** button to activate the Emergency Alarm Feature. The indicator lights and the display flashes "EMERGENCY" while the alarm is sent.

Note

For units with the Silent Emergency option, see paragraph 7.3.

Note

If your radio is equipped with an external emergency switch, it performs the same function as the **[Emer]** button.

You hear a Central Acknowledgement tone when the system central controller receives the alarm. A Dispatcher Acknowledgement tone of four beeps sounds and the radio automatically returns to normal operation.

7.3 SILENT EMERGENCY ALARM

Press the **[Emer]** button to activate the Silent Emergency alarm option.

Note

If your radio is equipped with an external emergency switch, it performs the same function as the **[Emer]** button.

During a silent Emergency Alarm, the indicator below the **[Emer]** button does not light and the receiver audio mutes so that no indication is given that an Emergency Alarm has been sent.

Press the PTT button or press and hold the **[Emer]** button until an alert tone sounds to exit the Silent Alarm mode.

7.4 EMERGENCY CALL/ALARM COMBINATION

If your radio is equipped with both Emergency Call and Alarm features, the radio automatically proceeds to the Call mode after the Alarm is acknowledged. Press the **[Emer]** button to activate the Emergency Call/Alarm feature. The indicator lights and the display flashes "EMERGENCY" while the alarm is sent.

Note

For units with the Silent Emergency option, see paragraph 7.3.

Note

If your radio is equipped with an external emergency switch, it performs the same function as the **[Emer]** button.

You hear a Central Acknowledgement tone when the system central controller receives the alarm. A Dispatcher Acknowledgement tone of four beeps sound and the display continues to flash "EMERGENCY".

Note

Press PTT to exit the silent mode if Silent Emergency Alarm is used with Emergency Call.

Press the microphone PTT to initiate the Emergency Call as defined by the System Manager (i.e. Ruthless Preemption, Top of Queue, etc.)

After completing the Emergency Call, press and hold the **[Emer]** button until an alert tone sounds and the indicator goes off.

8. Dynamic Regrouping Option *SMARTNET* Models Only

The Dynamic Regrouping option allows the dispatcher to temporarily reassign selected individuals operating in separate fleets and/or subfleets into a single group.

8.1 RECEIVING A DYNAMIC REGROUPING ID ASSIGNMENT

When you receive a Dynamic Regrouping ID assignment, a unique alert tone sounds. This unique chirp indicates the radio has been dynamically reconfigured. The display indicates the new dynamic mode assignment. Names for dynamic modes (such as "16 DYNAMIC" or "8 TACTICAL" etc.) are field programmable.

When you press the PTT button, your radio transmits on the dynamically assigned mode.

To see if your radio has a Dynamic ID assignment, momentarily press the **[Rpgm]** button. If the radio is not currently regrouped, the display shows "DYN REG OFF". This indicates the Dynamic mode is currently invalid. The display shows "DYN REG ON" if the radio has been regrouped.

If no Dynamic Regrouping assignment is made, you hear a low pitched continuous tone if you select a dynamic mode. This low tone indicates your selection is invalid.

The dispatcher may Regroup a unit in one of the following two ways.

- Select Disabled.
- Select Enabled.

8.1.1 Select Disabled

Units regrouped and Select Disabled cannot change modes. The dispatcher has specifically chosen to keep you (the mobile unit) in the Dynamic Group and to not allow you to change to any other mode.

8.1.2 Select Enabled

Units regrouped and Select Enabled may choose the mode to operate on. Therefore, after a Dynamic Regrouping has occurred, you may still be able to use the **[Mode]** rocker to select any of the available talk groups; including the dynamic group.

8.2 REQUESTING DYNAMIC REGROUPING

To request regrouping, press and hold the **[Rpgm]** button. A Central Acknowledge tone sounds to indicate your request was received by the System Central Controller. The display changes to "PLEASE WAIT" while the request is being processed.

If the Regrouping request is not acknowledged within 6 to 8 seconds, the display shows "RQST NO ACK" and returns to normal operation.

If the Regrouping request is acknowledged, a Dispatcher Acknowledge tone sounds (4 beeps) and the display returns to normal operation. This indicates the dispatch terminal has logged the Regrouping request.

9. Automatic Multiple Site Switching (AMSS) Option *SMARTNET* Models Only

The Automatic Multiple Site Switching (AMSS) option allows you to communicate beyond the reach of a single site. In a system where wide area coverage is required, multiple trunking sites are utilized.

The AMSS option automatically switches your radio to a different site when the signal of the current site becomes too weak. This typically happens as the radio moves out of range of one site and into the range of another.

9.1 OPERATOR INITIATED AMSS OPERATION

Press the **[Site]** button to check which site your radio has currently selected. You can manually initiate a scan to another site during weak signal conditions by pressing and holding the **[Site]** button until an alert tone sounds. The display then shows "SITE SCAN" and begins to search for the next available site.

9.2 LOCKING ONTO A SITE

If you are aware that weak signals are common in particular areas, use the AMSS Lock function to prevent the radio from automatically scanning for a new site.

Press the **[Lock]** button to display the current status of the AMSS Lock. "SITE LOCK" inhibits the radio from automatically scanning for new sites. "SITE UNLOCK" allows automatic scanning to function.

Press and hold the **[Lock]** button until the display changes to the alternate condition.

10. System Search And Lock

Press the **[Srch]** button to turn the System Search and Lock feature on or off. The mode showing on your display when the feature first turns on is called the home site. When your vehicle goes out of range of the home site's repeater, the System Search and Lock feature searches through a pre–determined list of conventional and/or trunking modes and locks onto a system site that is in the current coverage area.

Press and hold the **[Srch]** button to initiate a site scan. The red indicator light flashes while the radio searches for a new site. Once your radio finds a new site, the new site's mode name appears on the display.

Your radio periodically looks back to the home site during normal operation. The radio automatically returns to the home site when your vehicle returns within range of the home site.

11. Telephone Interconnect Option

The Telephone Interconnect option allows you to place or receive private telephone calls from the mobile radio. The system central controller performs the operation. All calls between you and a land line user are private regardless of who initiates the call.

The Telephone Interconnect option allows you to dial numbers manually or from a pre–defined list. The radio can store up to nine phone numbers in memory, plus the last number called. Names for the phone numbers may be field programmed.

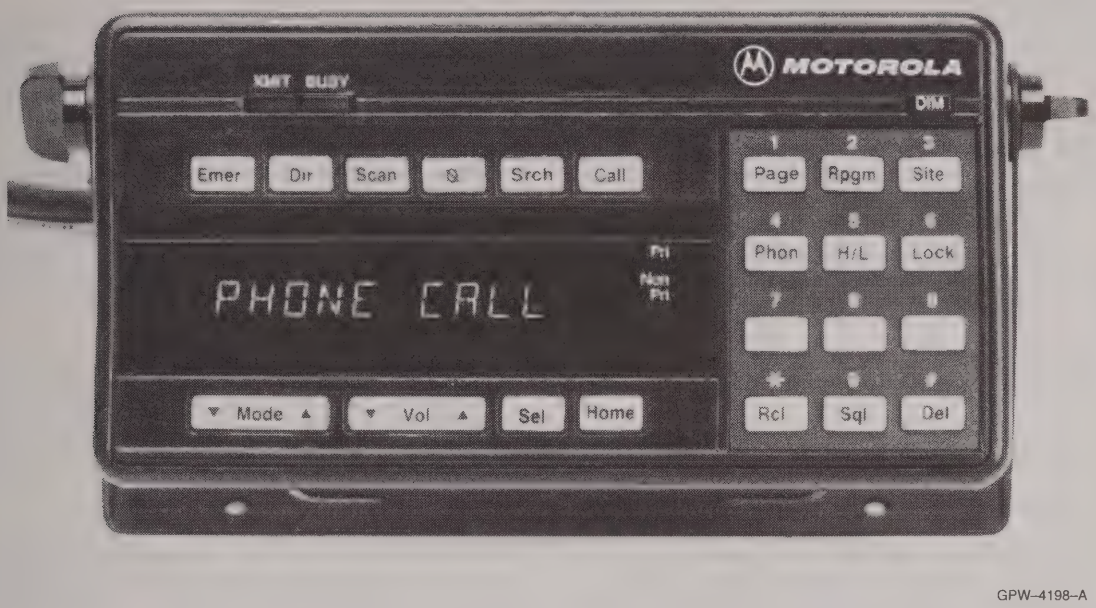
11.1 DIALING CALLS MANUALLY

There are two methods of manually dialing a phone number.

- Scratch pad dialing.
- Keypad dialing.

11.1.1 Scratch Pad Dialing

Press the **[Phon]** button to make a call. An alert tone sounds and the display alternates between "SCRATCH PAD" and the last number dialed. The scratch pad memory stores the number after dialing until another number is entered from the keypad.



GPW–4198–A

Figure 2. SYNTOR X 9000E *Telephone Interconnect Option*

The scratch pad allows you to enter the digits of the number you are calling and make corrections be fore the number is dialed. Press the **[Del]** button twice if you enter a wrong number. This erases the last digit you entered. Press the **[Sel]** button when the number you are calling is on the display.

If the system is busy, four tones (similar to a telephone busy signal) sound. The system places the call in a queue so when a channel becomes available, the system automatically dials the number.

When the party you are calling answers, explain that only one person can talk at a time. Each time you release your microphone PTT button, the listener hears a soft tone. This tone is their cue to begin talking. Proceed with your conversation in a normal PTT manner.

Press the **[Home]** button to end the call, exit the phone mode, and return to normal radio operation.

11.1.2 Keypad Dialing

Keypad dialing allows you to send Dual Tone, Multiple Frequency (DTMF) tones as the keypad digits are pressed. This is often necessary when using PBX's, long distance services, etc.

Press the **[Phon]** button to make a call. An alert tone sounds and the display alternates between "SCRATCH PAD" and the last number dialed. The scratch pad memory stores the number after dialing until another number is entered from the keypad.

Use the **[Mode]** rocker to scroll to "KEYPAD DIAL" then press the **[Sel]** button and wait for a dial tone.

If the system is busy, four tones (similar to a telephone busy signal) sound. The system places the call in a queue so when a channel becomes available, you may begin dialing the number using the keypad.

When the party you are calling answers, explain that only one person can talk at a time. Each time you release your microphone PTT button, the listener hears a soft tone. This tone is their cue to begin talking. Proceed with your conversation in a normal PTT manner.

Press the **[Home]** button to end the call, exit the phone mode, and return to normal radio operation.

11.2 DIALING FROM MEMORY

Press the **[Phon]** button to make a call. An alert tone sounds and the display alternates between "SCRATCH PAD" and the last number dialed. The scratch pad memory stores the number after dialing until another number is entered from the keypad.

Use the **[Mode]** rocker to scroll to the name/number you wish to call. Press the **[Sel]** button to begin the auto–dial sequence.

If the system is busy, four tones (similar to a telephone busy signal) sound. The system places the call in a queue so when a channel becomes available, the system automatically dials the number.

If the phone number you are dialing has a "P" character (see paragraph 11.3) in it, the radio de–keys until you press the **[Sel]** button again. This allows you to access a telephone network that uses multiple phone lines. By pressing **[Sel]** the second time, you send the remainder of the phone number.

When the party you are calling answers, explain that only one person can talk at a time. Each time you release your microphone PTT button, the listener hears a soft tone. This tone is their cue to begin talking. Proceed with your conversation in a normal PTT manner.

Press the **[Home]** button to end the call, exit the phone mode, and return to normal radio operation.

11.3 STORING PHONE NUMBERS

The Telephone Interconnect option includes special key sequences (characters) to help program certain features available to the option. These characters are:

- Press * – displays "*"
- Press # – displays "#"
- Press * # – displays "P". Used to pause in the middle of dialing. Press **[Sel]** to continue.
- Press # # – erases the previous digit.

Press the **[Phon]** button to store phone numbers in memory. An alert tone sounds and the display alternates between "SCRATCH PAD" and the last number dialed. Use the **[Mode]** rocker to scroll until "STORE PHONE" displays then press **[Sel].** The **[Mode]** rocker now scrolls through the storage locations for your phone numbers/names. Phone names are field programmed. The display shows "PHONE 1", "PHONE 2" . . . etc. The display alternates from the phone name to number every two seconds to allow you to review a number before changing it.

Enter a phone number at the memory location you have picked using the keypad. If a phone number is already at this memory location, the new number replaces it.

Press **[Sel]** or **[Home]** button to store the phone number in memory. The **[Sel]** button allows you to continue through the storage locations and make additional changes. The **[Home]** button stores the phone number and returns to normal radio operation.

11.4 RECEIVING A TELEPHONE CALL

Note

If your radio has the External Alarms (Horn and Lights) option, see the External Alarms section of this manual.

A ringing tone sounds when your radio receives a telephone call. Press **[Phon]** to answer. An alert tone sounds and the display shows "PHONE CALL". Press the microphone PTT to begin conversation.

Press the **[Home]** button to end the call, exit the phone mode, and return to normal radio operation.

12. Status/Message Options

Status/Message are two separate options you can use to automatically transmit pre–defined status codes or message codes. The option you choose is supplied with a dedicated set of buttons installed in an Auxiliary Switch Panel housing. The Auxiliary Switch Panel mounts directly to the control unit.

Press the appropriate status or message button to automatically send a status/message code.

A Central Acknowledge tone sounds after the status/message code is sent and received. The red indicator light blinks for 5 to 6 seconds while waiting for a Dispatcher Acknowledgement.

When an acknowledge is received, a Dispatcher Acknowledgement tone (4 beeps), sounds and the Status or Message indicator lights solid. The solid indicator light shows the last Status or Message acknowledged by the dispatch terminal.

When an acknowledge is NOT received, the indicator continues to blink until you press the **[Del]** button. The display shows "STS NO ACK" or "MSG NO ACK", depending on the type of code. At the same time, the indicator above the last acknowledged Status or Message lights.

13. External Alarms Option

The External Alarms (Horn and Lights) option alerts you to incoming messages while you are out of your vehicle. You may select from three alarm settings before leaving your vehicle. These include;

- Horn on.
- Lights on.
- Horn and Lights on.

Press the **[H/L]** button to turn the External Alarms option on or off. Turn the option on. The display alternates between the currently selected mode and the type of Alarm (i.e. "HORN ON") last activated.

Press and hold the **[H/L]** button until an alert tone sounds. The display shows your current alarm selection. To change the alarm setting, use the **[Mode]** rocker to scroll through your choices; "HORN ON", "LIGHTS ON", or "HRN/LTS ON". Press **[Home]** to enter the new alarm setting, turn on the alarm option, and return the radio to normal operation.

The External Alarms option setting activates when any of the following occur.

- Receiving an Individual Selective Call.
- Receiving an Individual Page.
- Receiving a Telephone Call.

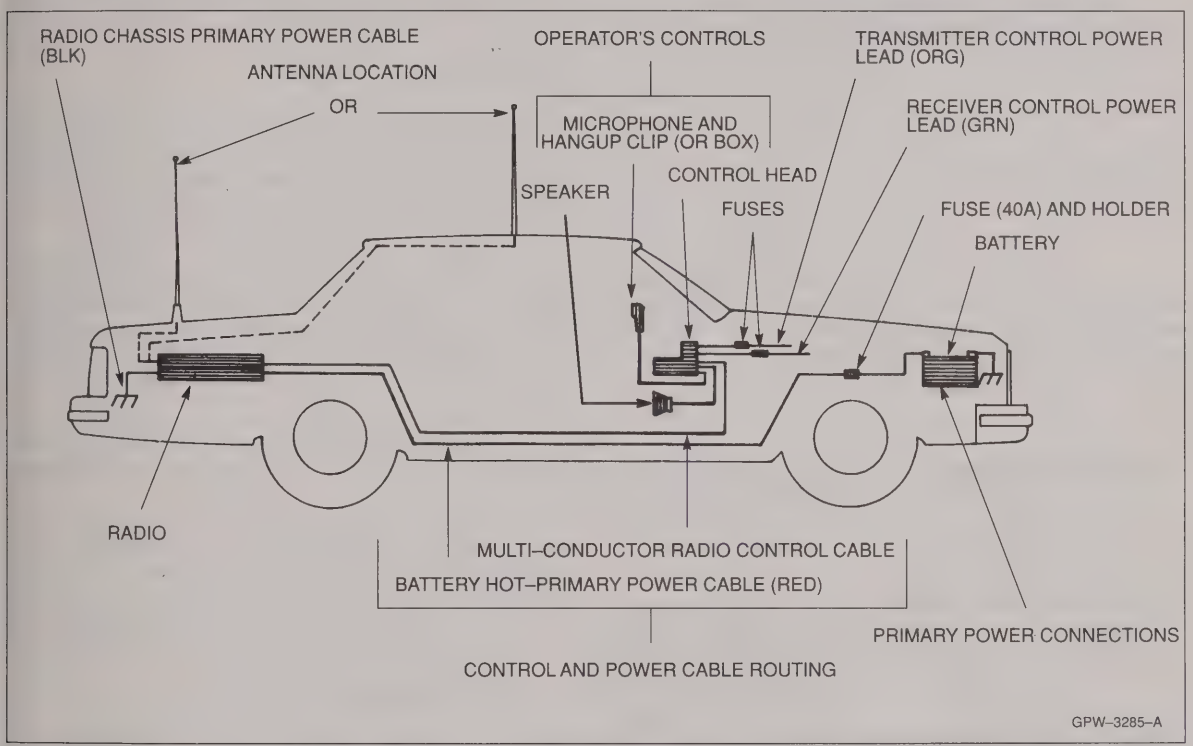


Figure 1. Installation Planning

1. Pre–Installation Tests

Although the factory aligns the equipment accurately, mishandling in transit may disturb some of the adjustments. In any case, FCC regulations require the checking of transmitter frequency and deviation at the time of installation. Therefore a pre–operational check is mandatory. To make a complete check, follow the sequence of tests presented below. The tests are described in more detail in the Maintenance and Troubleshooting Section of this manual.

(1) Check the highest transmit frequency (highest repeater frequency) and adjust as required. This adjustment also corrects any receive frequency errors caused by the reference oscillator.

(2) Measure the transmitter power output at the highest transmit frequency, and make adjustments as required.

(3) Measure the transmitter deviation at the highest transmit frequency (highest repeater frequency) and make the necessary adjustments.

(4) Measure the transmit frequencies.

(5) Measure the receive frequencies.

(6) Measure the 20 dB–quieting signal levels.

(7) Measure the PL or DPL sensitivity in PL/DPL modes. Repeat Steps 4 through 7 for each mode.

(8) Check the VSWR of the antenna after installing it in the vehicle.

2. Installation Planning

See Figure 1 for information on the antenna location, operator's controls, radio location, control and power cable routing, transmitter control power lead, receiver control power lead, primary power connections, and other accessories.

WARNING

For vehicles equipped with electronic anti–skid braking systems, see the "Anti–Skid Braking Precautions," Motorola publication number 68P81109E34. This document is available free of charge.

2.1 ANTENNA LOCATION

The best location for the antenna is at the center of the vehicle roof. A good alternate location is at the center of the trunk lid. Be sure that the antenna cable can be acceptably routed to the radio before mounting the antenna. See the antenna instruction manual for details.

CAUTION

Antennas must be installed at least two feet (0.6 meter) from vehicle operators and passengers unless shielded by a metallic surface.

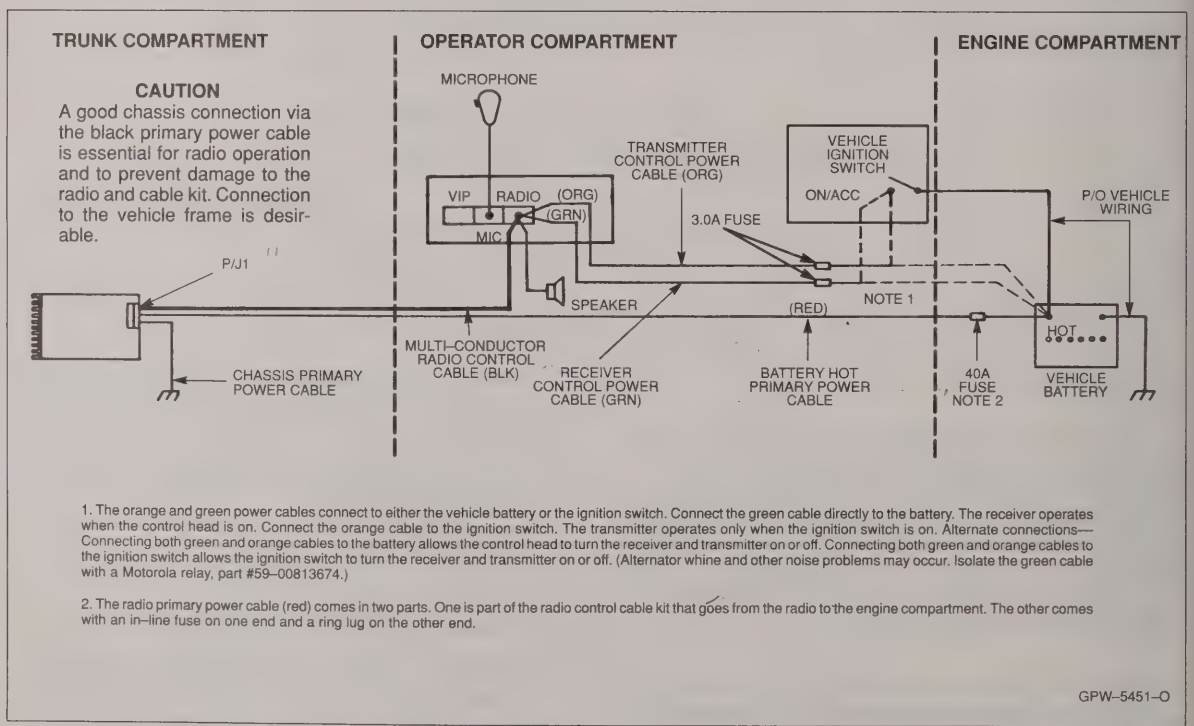
2.2 RADIO LOCATION

In most vehicles, the best location for the radio unit is the floor of the trunk compartment. When considering location, make sure to protect the radio from dirt and moisture. Make sure there is sufficient space around the radio to allow adequate cooling and permit removal of the unit.

2.3 OPERATOR'S CONTROLS

Recommended mounting surfaces for the control unit, microphone hang–up clip, and speaker are the following: under the dashboard, on the transmission hump, or on the center console. The speaker may be mounted on the firewall.

Adjustable trunnions are supplied for mounting the control unit and the speaker, allowing a number of mounting positions. The installation must not interfere with the operation of the vehicle or its accessories, nor disturb passenger seating or leg room. The control unit and the microphone hang–up clip must be within convenient reach of the user(s).



1. The orange and green power cables connect to either the vehicle battery or the ignition switch. Connect the green cable directly to the battery. The receiver operates when the control head is on. Connect the orange cable to the ignition switch. The transmitter operates only when the ignition switch is on. Alternate connections—Connecting both green and orange cables to the battery allows the control head to turn the receiver and transmitter on or off. Connecting both green and orange cables to the ignition switch allows the ignition switch to turn the receiver and transmitter on or off. (Alternator whine and other noise problems may occur. Isolate the green cable with a Motorola relay, part #59–00813674.)

2. The radio primary power cable (red) comes in two parts. One is part of the radio control cable kit that goes from the radio to the engine compartment. The other comes with an in–line fuse on one end and a ring lug on the other end.

GPW–5451–O

Figure 2. Cabling Interconnection Diagram

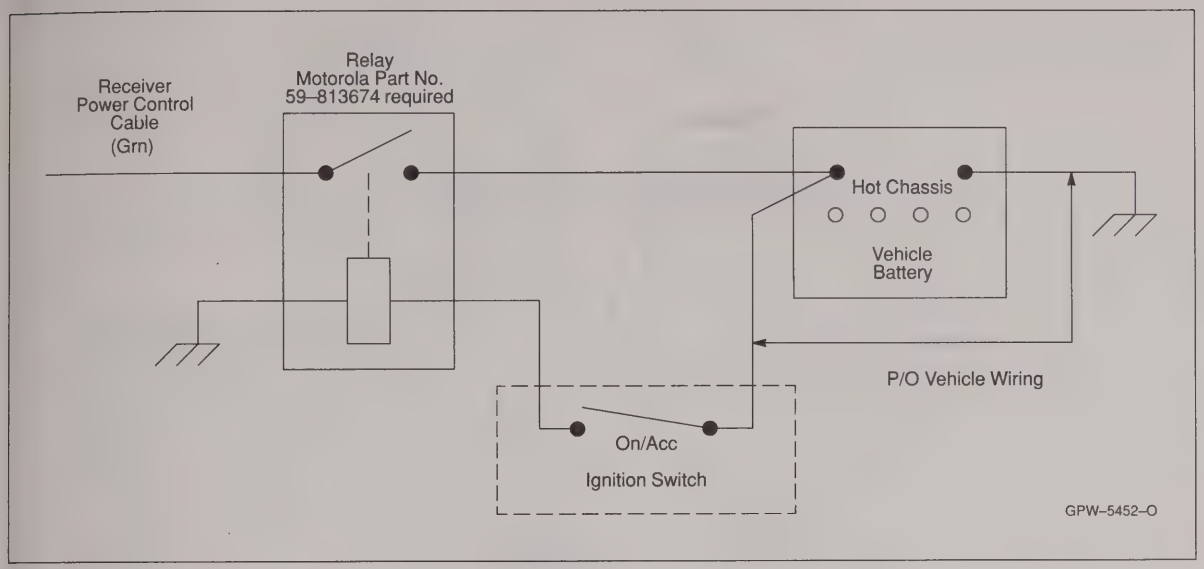


Figure 3. Power Control Isolation Detail

2.4 CONTROL AND POWER CABLE ROUTING

Many vehicles have wire troughs in the door sills. If the vehicle has this feature, use the troughs to provide maximum protection for the cable and to simplify the cable installation.

In vehicles without wiring troughs, route the control and power cables where they are protected from pinching, sharp edges, and crushing. One suggested route is along one side of the drive shaft hump under the carpet. Use grommets where the cable passes through holes in metal panels.

2.5 PRIMARY POWER CONNECTIONS (RED)

The best power connection point for the battery hot primary power lead is at the battery hot terminal. Points that connect directly to the battery terminal with sufficient current–handling capabilities may also be used. Make certain that the point chosen remains close to 13.6 volts; some systems switch to a higher–than–normal voltage during starting.

2.6 TRANSMITTER CONTROL POWER LEAD (ORANGE)

Connect this lead to the ignition switch (recommended) or directly to a battery hot supply. See Figure 2.

2.7 RECEIVER CONTROL POWER LEAD (GREEN)

Connect this lead to a battery hot supply (recommended) or to the ignition switch. See Figures 2 and 3.

2.8 RADIO CHASSIS PRIMARY POWER CABLE (BLACK)

The radio chassis primary power cable should connect to a good ground point on the vehicle chassis. See Figure 2.

3. Cable Routing

Note

Cables routed near metal edges or through holes may be damaged. Be sure to use rubber grommets, if necessary, to protect the cables.

(1) Determine the radio's location in the trunk compartment and leave enough slack cable to permit the plug to be easily connected or disconnected from the radio.

(2) Work from the trunk space forward. In some cars there is enough room below the fiberboard trunk partition to admit the cables. If this is not the case, make an opening through the partition. Remove the back seat.

(3) If the vehicle has wire troughs, run the cables in the wire troughs. Otherwise, route the cables under the floor covering alongside the drive shaft hump. Pull the cables into the back seat area, under the floor mats, under the front seat, and under the front mats, exiting up under the dash at the firewall. Pull the control unit end of the multi–conductor cable to the approximate location of the control unit. Route the red power cable into the engine compartment through any convenient hole in the firewall.

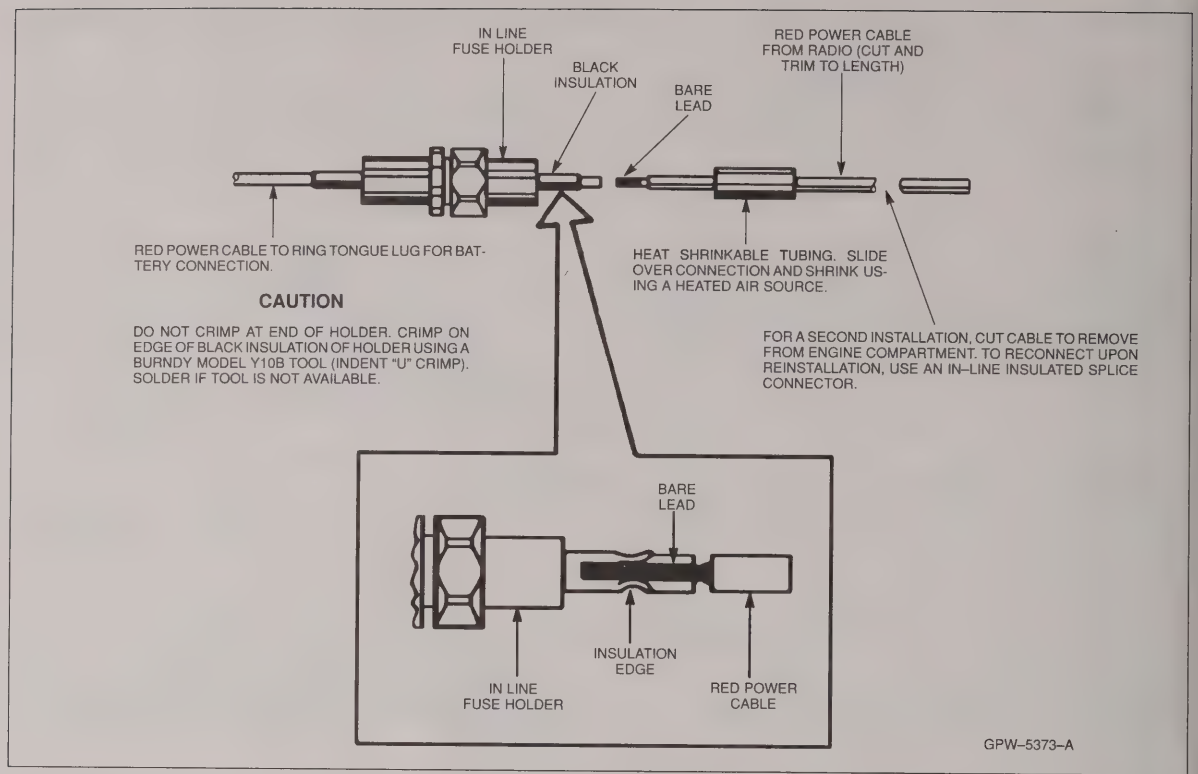
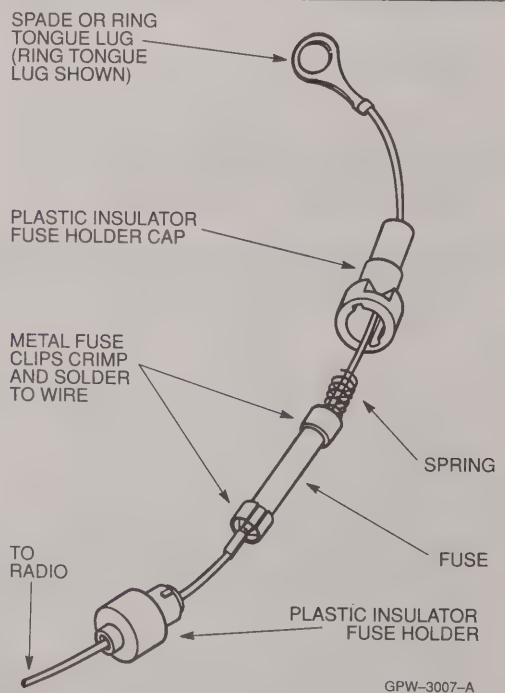


Figure 4. Fuse Installation



parts list

HLN4952A Fuse Kit for Green and Orange Leads — MXW–2273–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	14–82882A01	insulator, fuse hoder body
	14–82883A01	insulator, fuse holder cap
	29–00136968	lug
	29–00824456	ring tongue lug
	29–00865065	ring tongue lug
	41–82885A01	compression fuse spring
	42–82884A01	fuse clip
	65–00020404	3 amp fuse, 250V, (quantity 2)

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HKN4051A Cable and Fuse — MXW–4224–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	01–80701T88	30" lead and lug assembly
	29–84528B05	ring lug
	30–00812505	8 strand wire, red
	03–00139931	tapping screw
	09–84277B02	fuse receptacle
	10–10043A02	red tie wrap
	37–00134371	heatshrink tubing
	38–84383D02	protective cap
	42–84275B01	fuse retainer
	65–84161B01	40 amp fuse (5AG)

7/15/89

Figure 5. Fuseholder Assembly and Parts List

(4) Pull the red power cable into the engine compartment. A cable fuse kit comes with a ring tongue lug on one end and an in–line fuseholder on the other. Each cable includes a small section of heat–shrinkable tubing. Trim any excess length of red cable. Slide the heat–shrinkable tubing over the red power lead from the radio. Slide the strapped portion of the red cable into the end of the in–line fuseholder and crimp the joint using a Burndy Model Y10B (indent "U" crimp). If this tool is not available, solder the joint. See Figure 4.

(5) Slide the heat–shrinkable tubing over the connection and shrink the tubing with a Motorola Model ST697 Heat Gun or equivalent heated air source. Remove the fuse from the fuseholder and reconnect the holder. Fasten the ring–tongue lug on the end of the cable to the battery's ungrounded terminal or to some point directly connected to the ungrounded terminal of the battery (such as the starter solenoid). Move the in–line fuseholder to a convenient location on one of the sheet metal parts of the engine compartment. Center punch and drill a 9/64" (.140") hole through the mounting surface. Then mount the bracket with the #10–16 x 1/4 self–tapping sheet metal screws. Do not install the fuse until the entire radio installation is complete.

(6) The control unit power cable kit contains two separate wires, one orange and the other green. The orange wire is 66 inches long and the green wire is 106 inches long. A fuse kit hardware bag comes with the radio. This bag contains crimp–on type ring tongue lugs and crimp–on type spade lugs. The spade lugs allow connection to hot leads at the fuse block of the vehicle and the ring tongue lugs permit attachment to screws of terminals. Determine from Table 1 which radio functions are to be switched through the vehicle ignition switch. A typical system allows the receiver to operate with the radio switched on while the ignition is off, but the transmitter does not operate unless the ignition is on. In this case, connect the orange wire to the accessory terminal of the ignition switch and the green wire to the ungrounded terminal of the battery or starter solenoid.

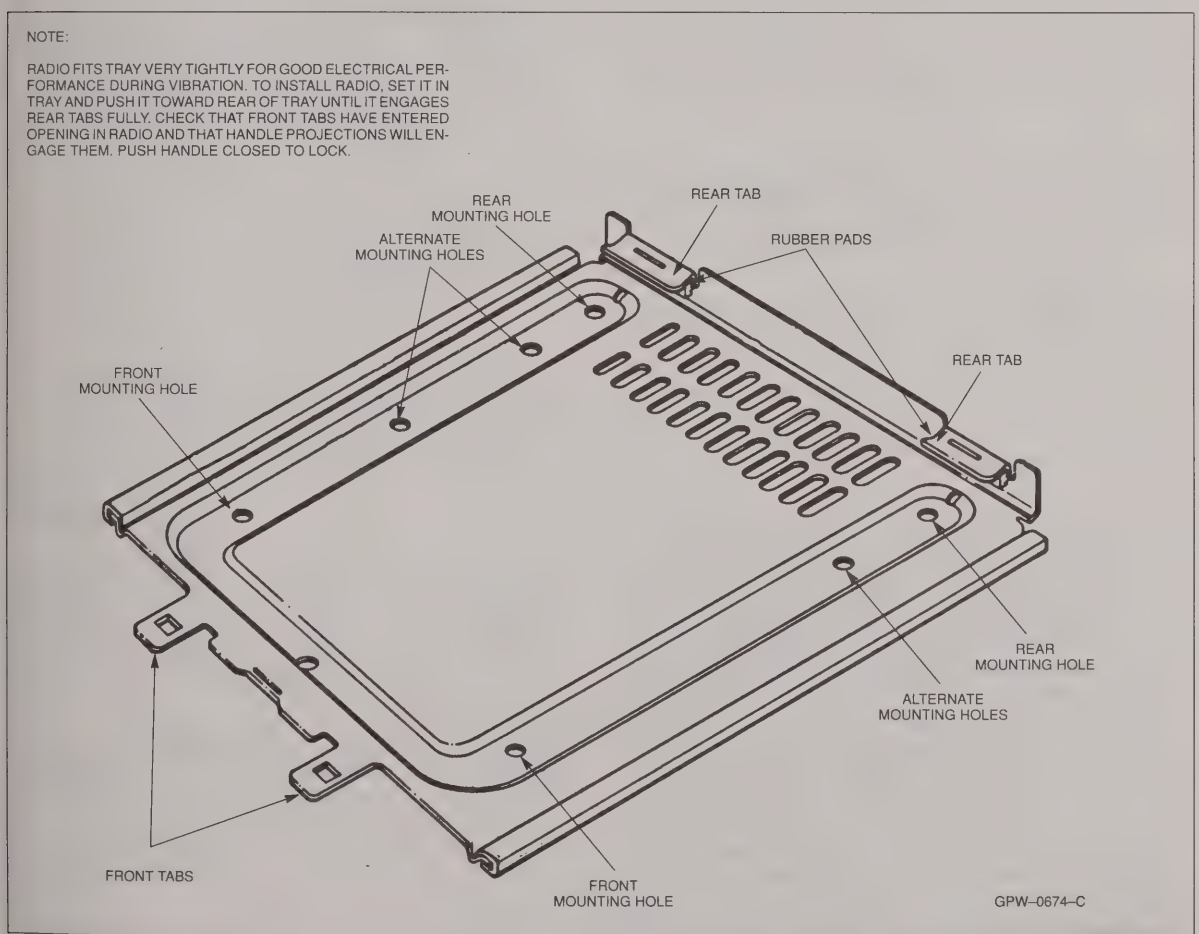

Figure 6. Radio Mounting Tray

CAUTION

Do NOT connect either lead to the ungrounded terminal of the battery at this time.

(7) If either wire is to be connected in the engine compartment, pass the end of the wire through the same firewall hole that the red power cable uses. At this point, install a fuse in both wires.

(8) The following procedures apply to both the green and orange wires. See Figure 5 for more information. Cut the wires about 10 inches from the end. Strip the insulator from both sides so that about 1/8 inch of the wire is exposed. On the end still connected to the cable kit, install the plastic insulator fuse holder cap. On the same wire, crimp one of the metal fuse clips onto the exposed wire and apply solder for a good connection. On the 10–inch loose wire, crimp another metal fuse clip onto the exposed wire and apply solder. Install the fuse (both are three–amp) into the fuse clips on both sides. Slide the spring on the wire to the fuse. Then slide the plastic insulated fuse–holder over the loose end of the wire so that the spring is inside the fuseholder. Now, twist the fuseholders until they lock together.

(9) On the loose ends of the green and orange wires, strip the insulator and crimp either the spade or ring tongue lug on the wire. Solder the crimped connection.

(10) Do not dress the wires at this time. Go to the next procedure.

4. Radio Installation

(1) Choose a location where the mounting screws are not directly above the fuel tank, fuel line, or other vital parts. Permanently install the mounting tray of the radio to a flat surface with a four–point mounting scheme or, if on an uneven surface, with a three–point mounting scheme. (Four–point mounting is strongly recommended over three–point, especially in vehicles subject to extreme vibrations.) The raised shelf in some car trunk compartments makes a good mounting place. Place the radio at one side to allow space for luggage. Leave at least eight inches in front of the radio so that the handle can be opened and the programming cable can be plugged into the radio. Locate the radio so that the black ground lead in the trunk can reach a good chassis ground point in the trunk. Determine the radio's final position, unlock the radio, open the handle and lift the radio assembly away from the mounting tray (pull forward and upward to release the radio assembly). Mount the mounting tray as illustrated in Figures 6 and 7.

(2) When mounting the radio securely to the trunk floor in some vehicles, the front panel may press against the floor or floor cushioning. Also, some vehicles make it necessary to mount the radio directly over the fuel tank. Always make a preliminary check to see how far the screws will extend below the trunk floor. Do not puncture the fuel tank. If either condition exists, insert one of the thick spacer washers between the bottom of the mounting tray and the floor at each of the four mounting holes. The washers help to keep the radio level, especially when the floor is covered with a "spongy" mat such as soft rubber. Replace the radio assembly by sliding the radio onto the tray at about the halfway point. Push straight back until the tray tabs enter the two window areas on the radio front and engage the handle tabs. Close by pushing the handle until it locks. The handle locks the radio to the mounting tray and conceals the top cover release button. Push the multi–conductor plug onto the male connector and rotate the thumbscrew clockwise to fully seat the connector. Reverse the procedure for removing the radio.

(3) Thoroughly clean the trunk floor surface before proceeding. Connect the black ground cable lug to a convenient location on the trunk floor. Center punch and drill a 3/16" (.187") hole through the mounting surface. Use a #14 x 3/4" self–tapping screw and the supplied 1/4" lockwasher to mount the cable lug. See Figure 8.

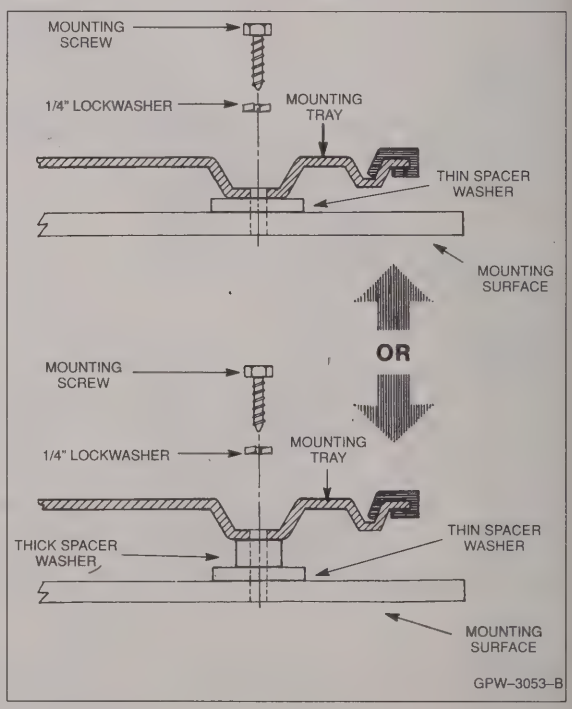

Figure 7. Radio Mounting Tray Installation Detail

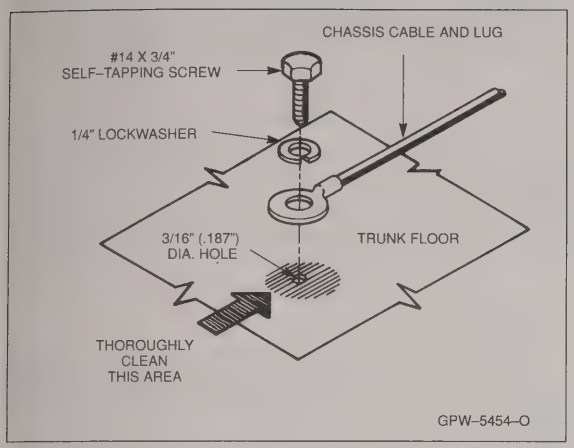

Figure 8. Radio Ground Connection

CAUTION

A good ground connection of the black cable is essential for radio operation and to prevent damage to the radio and cable kit. Grounding to the vehicle frame is desirable. On some late–model automobiles, the ground connection between the vehicle chassis and engine block is inadequate for good mobile radio operation. DO NOT compensate for this problem by connecting the radio ground directly to the battery. Connect a flexible metal ground strap between the engine block and a vehicle chassis point common to the radio ground. Be sure the strap is heavy enough to carry maximum transmitter supply current.

(4) All cables (including the antenna lead–in) should be dressed out of the way as much as possible to prevent damage. Mount the radio so the heatsink has the largest available air supply for cooling.

5. Microphone Installation

The microphone bracket must be within arm's reach of the operator. Measure this distance before actually mounting the microphone bracket. Since the bracket has a positive–detent action, the microphone can mount in almost any position. See the microphone instruction manual for more information.

After installation, connect the microphone plug to the receptacle on the control unit. Make sure that the clip on the control unit firmly engages the plug. Connect the microphone cable "S" hook to the proper hole in the strain relief clip on the rear of the control unit.

6. Speaker Installation

6.1 GENERAL

The speaker kit includes a trunnion bracket that allows the speaker to be mounted in a variety of ways. With the trunnion bracket, the speaker can mount permanently on the dashboard or in accessible firewall areas. The trunnion allows the speaker to tilt for best operation.

6.2 INSTALLATION WITH TRUNNION BRACKET

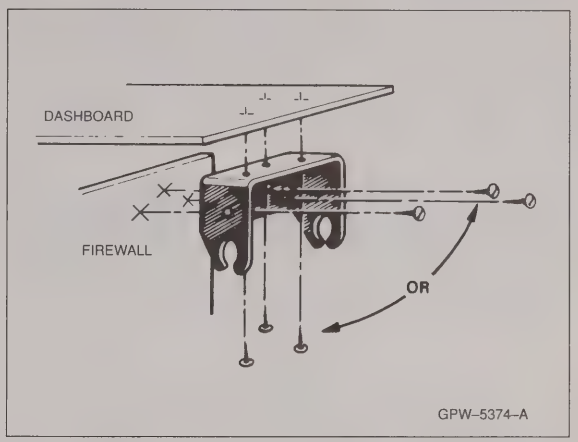

Figure 9. Standard Speaker Mounting

(1) Remove the trunnion bracket by loosening the two wing screws.

(2) Remove the three paper retainers and screws from the trunnion bracket.

(3) Remove the wall–mount bracket from its taped position on the hanger bracket. (Retain for future use.)

(4) Select a mounting position. If space limitations require the removal of the hanger bracket, remove the Phillips screw and slide the bracket out of the speaker housing. You need not disassemble the speaker housing to remove the hanger bracket.

(5) Mount the trunnion bracket with the supplied self drilling screws.

(6) Remount the speaker in the trunnion bracket and tighten the two wing screws.

(7) Plug the speaker lead into the control unit, making sure that the plug is solidly seated.

(8) Tie up surplus lead cable.

Note

Using the self drilling screws eliminates the need for predrilled holes.

7. Control Unit

7.1 MOUNTING CONSIDERATIONS

Examine the vehicle to find a suitable mounting location within the operator's reach. Although the trunnion mounting bracket can mount on a plastic dashboard, all four trunnion mounting screws should penetrate the dashboard's supporting

metal frame. If that is not possible, use a metal backing plate (not supplied) to strengthen the installation. The location should be convenient to the operator for viewing the display and operating the buttons and on–off switch, but vehicle operation should not be impaired and the driver's vision must not be obstructed.

If necessary, pull more cable into the dashboard area. Be sure all wires are clear of the instrument panel where holes are to be drilled.

7.2 INSTALLATION

(1) Mark the mounting location (see Figure 9) using the trunnion bracket as a template; drill four 5/32" holes. If mounting into a plastic surface, use a metal backing plate.

(2) Attach the trunnion bracket using all four #10–16 x 5/8" self–tapping screws supplied in the mounting kit.

Note

When the control unit is installed, it must not wobble or feel "spongy" when you press buttons. Use all four mounting screws and be sure they are tightly screwed into metal–either a dashboard support bracket or a backing plate.

(3) Plug in the radio cable connector and microphone cable connector in the proper location on the back of the control unit (see Figure 11). A "click" sounds when the connector snaps into place. Now connect the microphone cable "S" hook into the hole in the cable strain relief bracket on the back of the control unit.

(4) Plug in the Vehicle Interface Port (VIP) connector (see Figure 11) into the remaining location on the back of the control unit.

(5) Install the control unit to the trunnion bracket using the two wing screws. Rotate the control unit to the desired vertical position and tighten the wing screws.

8. Vehicle Interface Port (VIP)

8.1 GENERAL

The Vehicle Interface Port (VIP) allows the control unit to operate outside circuits and to receive inputs from outside the control unit. There are three VIP outputs which are used for relay control. There are also three VIP inputs which accept inputs from switches. See the cable kit section for typical connections of VIP input switches and VIP output relays.

8.2 OUTPUT CONNECTIONS

The VIP output pins are on the back of the control unit below the area labeled "VIP." Use these connections to wire control relays. One end of the relay should connect to switched B+, while the other side connects to a software controlled ON/OFF switch inside the control unit. The relay can be normally–on or normally–off depending on the VIP outputs' configuration. The control unit has 3 VIP output connections.

VIP OUTPUT NUMBER	SWITCHED B+ PIN NO.	ON/OFF SWITCHED PIN NO.
1	18	2
2	19	1
3	35	34

The function of these VIP outputs can be field programmed in the control unit. Typical applications for VIP outputs are external horn/lights alarm and horn ring transfer relay control. For further information on VIP outputs, see the control unit programming manual.

8.3 INPUT CONNECTIONS

The VIP input pins are on the back of the control unit below the area labeled "VIP." These connections control inputs from switches. One side of the switch connects to ground while the other side connects to a buffered input to the control unit. The switch can be normally–closed or normally–open depending on the VIP inputs' configuration. The control unit has 3 VIP input connections.

VIP OUTPUT NUMBER	GROUND PIN NO.	ON/OFF SWITCHED PIN NO.
1	20	4
2	21	3
3	36	37

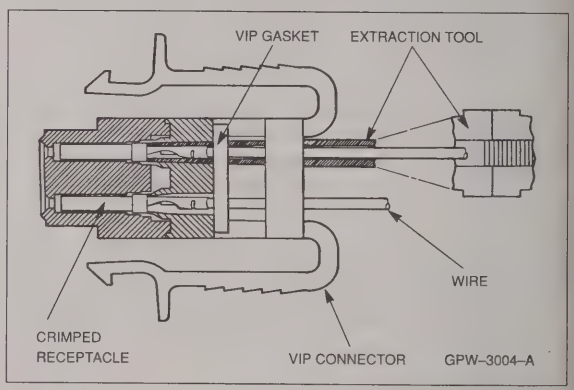

Figure 10. VIP Connector Detail

The function of the VIP inputs can be defined by field programming the control unit. Typical applications for the VIP inputs are for a foot switch or a horn ring switch. For further information on VIP inputs, see the control unit programming manual.

9. Power Connections (See Figures 1 and 2.)

(1) Replace the fuse in the in–line fuseholder of the red power cable coming from the radio in the trunk. Connect the green (and/or orange) fused wire(s) coming from the control unit to the ungrounded terminal (or source) of the battery.

(2) Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Drill 1/8" mounting holes and then attach the

clamps with four #8 x 3/8" tapping screws and four 1/4" lockwashers. Finally, be sure all in–line fuses are installed.

10. Antenna Installation

A diagram and complete installation instructions are supplied with each antenna ordered. See those installation instructions for pertinent information.

11. Conclusion of Installation

(1) Be sure the control unit and microphone PTT switches are off. Install the 40–amp fuse in the red primary power cable in–line holder. Install the 3–amp fuse in the orange cable in–line holder. Install the 3–amp fuse in the green cable in–line holder.

Note

If alternator or other noise is present in the received signal or in the transmission, see Motorola publications Number 68P81109E33 "Reducing Noise Interference" in Mobile Two–Way Radio Installations.

(2) Turn the radio on at the control unit and verify proper operation of all controls and indicators. Radio operation in some installations requires turning on the ignition. See Table 1. Perform a complete operational check of the radio.

(3) Dress the control and power cables out of the way to prevent damage (pull any excess cable into the trunk area) and secure them where necessary with the clamps and screws supplied. Replace the rear seat if it was removed for installing the cables.

Table 1. Radio Functions Connections

Conductor	Green	Orange	Green	Orange	Green	Orange
Connected to battery	•	•	•			
Connected to ignition switch				•	See Note	•
Ignition switch controls	No ignition switch control		Xmtr ignition switch controlled		Complete radio ignition switch controlled	
In any application, trim and strip wires. Crimp on ring lug for battery connections. For ignition switch connections, crimp on ring or spade lug (whichever is required).						

Note: In cases where alternator whine or interference is a problem, isolate the green lead with a relay (Motorola Part No. 59–00813674).

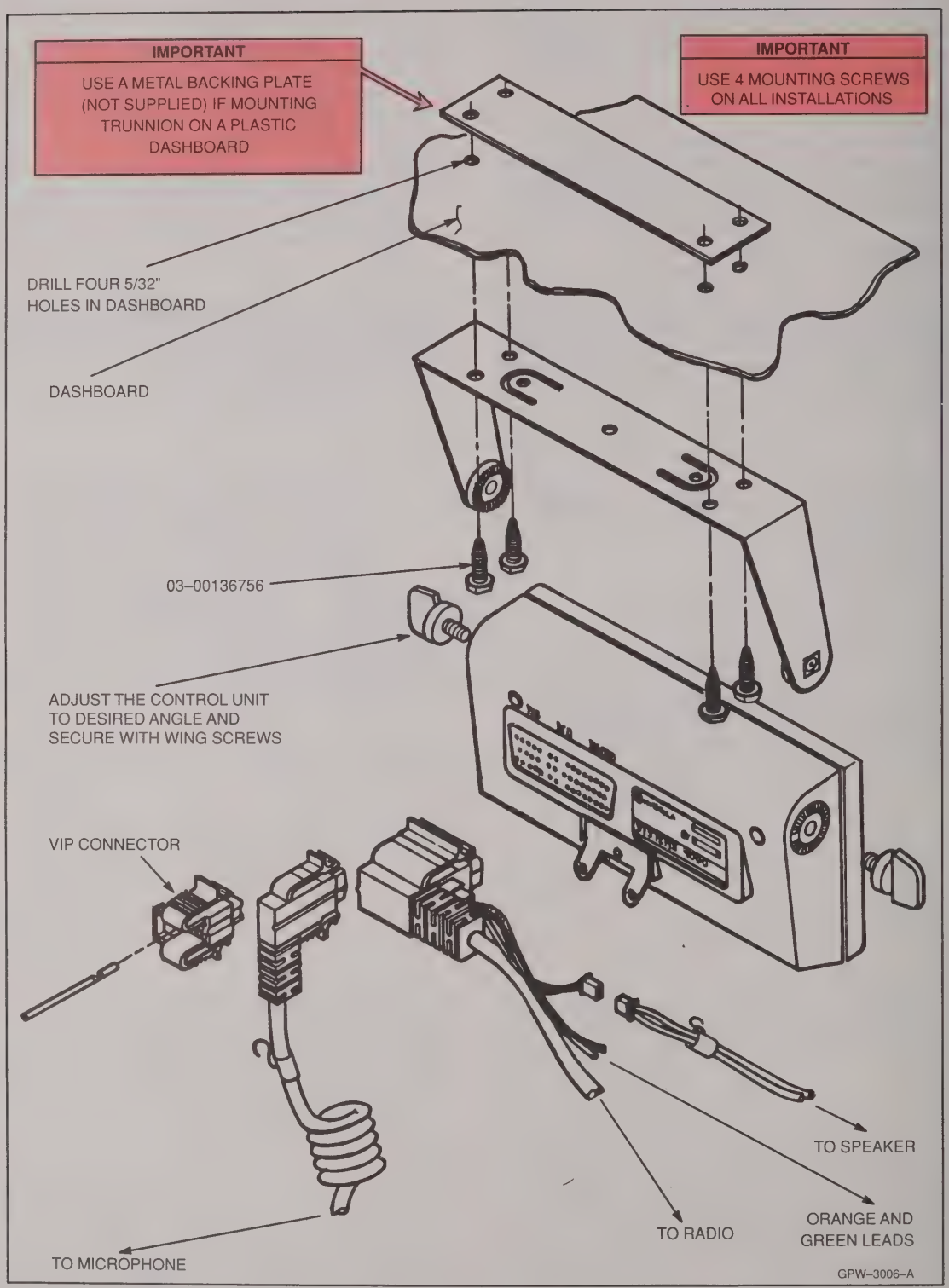

Figure 11. Control Unit Exploded View

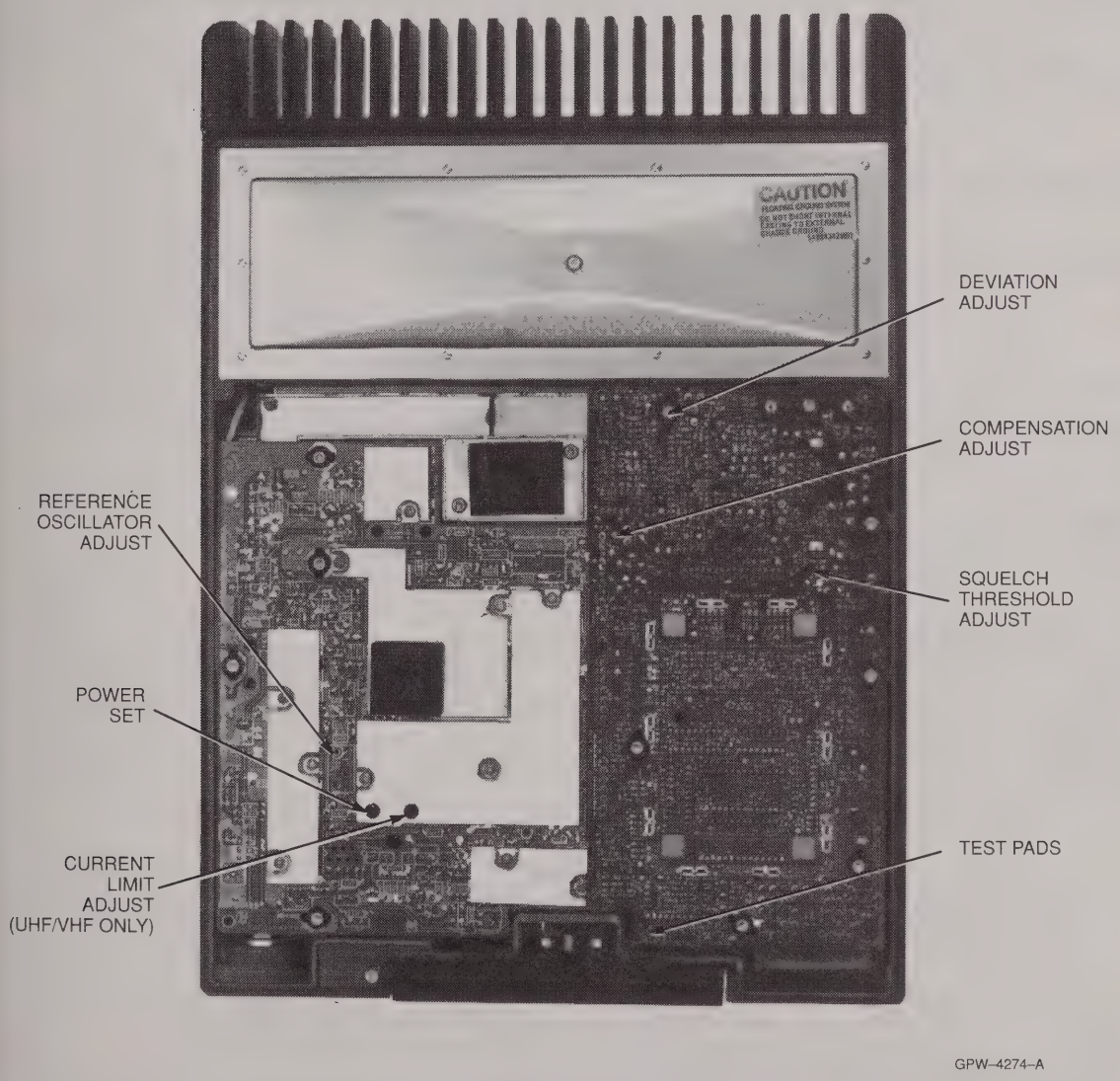

Figure 1. Typical SYNTOR X 9000/SYNTOR X 9000E *Radio (Top View)*

1.Recommended Test Equipment

Table 1. Test Equipment

General type	Application	Recommended Model	Minimum Specification
AC–DC VOM	DC Voltage measurements, general	Motorola T1009A	Measurement range: 0–15V DC Sensitivity: 20,000 ohms/volt
DC Multimeter	DC voltage readings requiring an input resistance meter	Motorola S1063B	Measurement range: 0–15 V DC Input resistance: 11 megaohms
AC Voltmeter	Audio voltage measurements	Motorola S1053C	Measurement range: 100 mV AC Input resistance: 1 megaohm
RF Voltmeter	RF voltage measurements	Motorola S1339A	Measurement range:100 µV–3V from 1 MHz–900 MHz Inputs:50 ohm and high impedance
Oscilloscope, Dual–Trace	Waveform observation	Motorola R1004A	Vertical sensitivity: 5 mV–10 V/division Horizontal time base: 0.2 µsec–0.5 sec./division
RF Wattmeter	Transmitter output power measurement	Motorola T1039 with appropriate element and T1013 RF dummy load	Measurement range: 0–50 watts
Frequency Meter	Transmitter frequency measurement	Motorola R1200 Service Monitor with high stability oscillator (X suffix) option. Frequency calibration recommended every 6 months or less.	Measurement range: 806–870 MHz Frequency resolution: 10 Hz
Deviation meter	Transmitter modulation deviation measurement	Motorola R1200 Service Monitor with SLN6350 Deviation Meter.	Measurement range: 0–10 KHz deviation Frequency range: 806–870 MHz
RF Signal	Receiver alignment and troubleshooting	Motorola R1200 Service Monitor with attenuator.	Frequency range: 806–870 MHz Output level: 0.1 µV–100,000 µV Must be capable of at least ± 3 kHz deviation when modulated by a 1 kHz tone
Audio Signal Generator	Audio circuit troubleshooting	Motorola S1067B	Frequency range: 20 Hz–20 kHz Output level: 50 mV–1 V
•Double–Balance Mixer	Receiver front–end adjustment	Mini–Circuits Laboratory Model ZAD–4	—
•Logic Probe	Check various digital devices	Motorola RTL–4014	—
Radio Test set	Meter readings at circuit metering points for alignment and trouble–shooting	Motorola S1056 Portable Test Set with a TEK–37 or TEK–37A Test Set Adapter or a Motorola TEK–5 Meter Panel with a TEK–40 Cable.	—
•Tuning Tool Kit	Receiver and transmitter alignment	Motorola TRN4513A	—
•DC Power Supply	DC power for shop service	Motorola R1011AA	120 v DC 0–40 A
PL Tone Generator*	Tone coded "Private–Line" decoder troubleshooting	Motorola S133B	Frequency range: 10 Hz–9999 Hz Output level: 0–3 V rms
•DPL Test Set**	"Digital Private–Line" encoder–decoder troubleshooting	Motorola SLN6413A	—

Note

All the test equipment listed above, with the exception of those marked with (•), can be replaced with the Motorola R2001 System Analyzer

CAUTION

In positive–ground systems, the case of the TEK–5 Meter Panel and portions of the S1056B Portable Test Set are hot with respect to the vehicle chassis due to the nature of the positive–ground installations. Take necessary precautions that the test equipment does not contact the vehicle chassis.

2. Radio Alignment And Adjustments

2.1 INTRODUCTION

The following four adjustments can be made to the *SYNTOR X 9000E* radio.

- Oscillator frequency.
- Deviation.
- Compensation.
- Transmitter power.

Perform all adjustments through the holes that are directly accessible on the RF board. (See Figure 1) Readjustment of the receiver is not recommended since the factory adjusts the receiver to allow a wide passband for all frequencies within the 851 MHz to 870 MHz radio model's range.

Note

See the list of recommended test equipment provided in this section of the manual.

2.2 OSCILLATOR FREQUENCY

Note

Perform the oscillator frequency adjustment before setting or checking the deviation adjustment.

(1) Use the mode rocker to set the radio on a carrier squelch transmit mode when adjusting the oscillator frequency.

(2) Use the portable test set to key the transmitter without modulation.

(3) Adjust the reference oscillator warp control (Figure 1) until the proper indication is obtained on the frequency meter.

(4) Use the mode rocker to scroll to all the remaining positions and check the proper transmitter frequencies. (No further oscillator frequency adjustments are required.)

2.3 DEVIATION

Note

Check deviation on all transmit channels when setting deviations; especially if wide transmit separations (more than 5 MHz) are required.

(1a) For PL or DPL radios only: Using the deviation adjust potentiometer, set deviation on the highest non–talkaround PL or DPL customer frequency to ±4.8 kHz.

(1b) For radios without PL or DPL: Set voice modulation to ±4.8 kHz on the highest non–talkaround customer frequency.

(2) Check the deviation on all transmit frequencies to ensure that it does not exceed 5 kHz.

2.4 COMPENSATION

Note

The compensation adjustment potentiometer is set at the factory and does not normally require readjustment.

Use this compensation adjustment procedure when any of the following conditions occur:

- If DPL transmit (encode) performance is poor,
- If the VCO reference oscillator or common circuits board is replaced,
- If the compensation potentiometer is replaced or inadvertently adjusted.

This procedure balances the transmit audio signal fed to the VCO and reference oscillator. This insures good DPL waveform fidelity and flat modulation response.

(1) Turn the deviation potentiometer (Figure 1) half way in a clockwise direction.

(2a) For PL or DPL radios only: Set the radio to the highest non–talkaround customer frequency.

(2b) For radios without PL or DPL: Apply a 100 Hz (+ 1 kHz deviation) signal to the microphone input.

(3) Connect the center lead of the shielded cable of an ac voltmeter to the modulation compensation test point (Figure 1) and connect the shield to the radio ground (A–). Set the voltmeter to the 1 mV range.

(4a) For PL or DPL radios only: Modulate the PL or DPL and adjust the compensation potentiometer until a null indication is obtained on the voltmeter. Cover the hole with tape to prevent accidental adjustment of this control.

(4b) For radios without PL or DPL: With a 100 Hz signal applied to the microphone input, adjust the compensation potentiometer until a null indication is obtained on the voltmeter. Cover the hole with a tape to prevent accidental adjustment of this control.

2.5 POWER MEASUREMENT

2.5.1 General Techniques

Important

The following information is to insure accurate measurement of RF power in the 800 MHz frequency spectrum. These instructions should be followed before performing any transmitter power tests.

The accurate measurement of RF power in the 800 MHz frequency spectrum requires great care be exercised since these frequencies are at the low end of the microwave spectrum. Test equipment setup and techniques used are more

critical for the 800 MHz frequency spectrum than at lower frequencies. Practices that work well for UHF frequencies (and lower) may not provide correct results in the 800 MHz frequency spectrum.

The use of coaxial adapters and cable assembly techniques effect the accuracy of 800 MHz frequency spectrum power measurements. Avoid the use of coaxial adapters if possible.

Measurements indicate that coaxial adapters, with UHF or BNC connector elements, can have a VSWR exceeding 2:1 in the 800 MHz frequency spectrum. A 2:1 VSWR (due to an adapter), when combined with the antenna or load, can prevent the radio from delivering its rated output.

The wattmeter used for making power measurements should have type N connectors and be rated for use in the 800 MHz frequency spectrum. The Motorola Model T1039 or equivalent wattmeter is recommended.

Connect the wattmeter to the radio antenna connector, using a type N–to–UHF coaxial adapter cable.

Note

This is the only place that a coaxial adapter cable is acceptable.

Use connectors with a plastic insulating dielectric for the coaxial adapter cable. Connectors, using bakelite as the insulating dielectric, or low cost adapters intended for citizens band service, should NOT be used.

The coaxial cable to adapt the UHF antenna connector on the radio to the type N connector on the wattmeter should be of a high quality type. Cable types such as RG400/U (Motorola part number: 30–84173E01) or RG142B/U (Motorola part number: 30–83278B01) are recommended. Care should be exercised in the assembly of the coaxial adapter cable to minimize impedance discontinuities at the connectors.

Accurate power measurements in the 800 MHz frequency spectrum are more difficult than at lower frequencies. Careful set–up of the measuring system is well worth the extra time and effort. These techniques are recommended for other 800 MHz Motorola radios.

2.5.2 Power Set Procedure (35W)

(1) To Terminate the radio with a wattmeter and a 50–ohm load.

Note

See the list of recommended test equipment provided in this section of the manual.

(2) Adjust the DC power supply voltage to 13.6 V.

Note

The transmitter employs a broadband power amplifier; any channel may be selected for the power adjustment procedure.

(3) Key up the transmitter and observe the output power indication. If the output power is greater than 15W, go to step 4; if the output power is less than 15W, go to step 5.

(4) Adjust the POWER SET potentiometer for an output power indication of 38W. A clockwise adjustment of this potentiometer (as viewed from the top of the radio) increases the output power; a counterclockwise adjustment decreases the output power. If the initial output power is significantly greater than 38W, it may suddenly drop during the course of this adjustment. If this occurs, go to step 5.

(5) If the output power is less than 15W, it is possible the high drive protection circuit of the power control has been activated. Adjust the POWER SET Potentiometer (Figure 1) counterclockwise until the output power drops to approximately 2 W. Re–key the transmitter and adjust the POWER SET potentiometer until an indication of 38W is obtained.

2.5.3 Power Set Procedure (15W)

(1) Terminate the radio with a wattmeter and a 50–ohm load.

Note

See the list of recommended test equipment provided in this section of the manual.

(2) Adjust the DC power supply voltage to 13.6 V.

Note

The transmitter employs a broadband power amplifier; any channel may be selected for the power adjustment procedure.

(3) Key up the transmitter and observe the output power indication. If the output power is greater than 15W, go to step 4; if the output power is less than 15W, go to step 5.

(4) Adjust the POWER SET potentiometer for an output power indication of 16W. A clockwise adjustment of this potentiometer (as viewed from the top of the radio) increases the output power; a counterclockwise adjustment decreases the output power. If the initial output power is significantly greater than 16W, it may suddenly drop during the course of this adjustment. If this occurs, go to step 5.

(5) If the output power is less than 8W, it is possible the high drive protection circuit of the power control has been activated. Adjust the POWER SET Potentiometer (Figure 1) counterclockwise until the output power drops to approximately 2 W. Re–key the transmitter and adjust the POWER SET potentiometer until an indication of 16W is obtained.

2.6 TRUNKING TEST

In normal trunking operation, the trunked *SYNTOR X 9000E* Dual Operation radio's microprocessor controls the RF

channel selection, transmitter key–up, and receiver muting functions. However, when the unit is on the bench for a tune–up and is out of its normal operating environment, the microprocessor does not key the PA or unmute the receiver.This prevents the use of normal tune–up procedure. To solve this problem, a special test routine was incorporated into the radio.

2.6.1 Initial Set–Up

Apply power to the radio under test. Short circuit the test pads (See Figure 1) for one second to set up the radio for the test routine.

2.6.2 Test Mode Channel Selection

(1) Apply power to the radio under test. Momentarily short the test pads together (as described above). The display shows operation on Channel F1, then the receiver unmutes.

(2) Step the radio to the next channel by quickly pressing and releasing the microphone PTT button within 200 mS (millisecond). The display shows Channel F2, after which the receiver unmutes. Repeat this procedure to step from Channel F1 up to Channel F4, with the display showing the channel number.

(3) The number of channels depends on the number of customer control channel frequencies. After the customer test frequencies, there are twelve factory test frequencies. Access the factory test frequencies by tapping the PTT button after the last customer test frequency. The display shows operation on FT1 (factory test frequency 1). Tap again for FT2; repeat this procedure for FT3 through FT12. When the radio is in FT12, an other PTT tap returns to the customer frequency F1. See Tables 2 and 3 for information on factory test frequencies.

2.6.3 Transmit Modes Alignment

Four transmit modes are used for various transmitter checks and adjustments:

- Silent carrier.
- Subaudible connect tone plus voice–low speed mode.
- High–speed ACK tone–high speed mode.
- DTMF tones.

2.6.3.1 Silent Carrier

The microprocessor keys the PA without data modulation when the PTT is pressed and held.

The MIC audio is enabled and the transmitter frequency, hum and noise, and voice deviation can be checked and adjusted. When the PTT button is released, the PA de–keys and the receiver unmutes.

2.6.3.2 Subaudible Connect Tone Plus Voice–Low Speed Mode

If the microphone PTT button is depressed and held again, the PA keys and the display shows "F1 LS". A busy tone also sounds. This step is used to adjust the maximum voice plus subaudible tone deviation.

- ±4.25 kHz to ±3.7 kHz deviation for voice.
- ±1.3 kHz to ±0.75 kHz deviation for sub–audible connect tone.
- ±5 kHz to ±4.45 kHz deviation total.

When the PTT button is released, the PA de–keys and the receiver unmutes.

Table 2. Test Frequency Chart

FACTORY TEST MODE	CUSTOMER TEST MODE	DTMF TONE
FT1	F1	#
FT2	F2	*
FT3	F3	9
FT4	F4	8
FT5	N/A	7
FT6	N/A	6
FT7	N/A	5
FT8	N/A	4
FT9	N/A	3
FT10	N/A	2
FT11	N/A	1
FT12	N/A	0

2.6.3.3 High–Speed Acknowledge

If the microphone PTT button is depressed and held for the third time, the PA keys and the display shows "F1 HS". The MIC audio is disabled. A talk permit tone also sounds. This step is used to check high–speed data deviation. The deviation level should be ±2.75 kHz to 3.5 kHz.

2.6.3.4 DTMF Tone

If the microphone PTT button is depressed and held for the fourth time, the PA keys and the display shows "F1 #" or the test frequency followed by the DTMF digit being sent. The DTMF tone produced depends on the test frequency selected. See Tables 2 and 3.

Table 3. Factory Test Mode Frequencies

FACTORY TEST MODE	RECEIVER FREQUENCY	CHANNEL NO.
FT1	851012500	0
FT2	859012500	320
FT3	865012500	560
FT4	869987500	759
FT5	852012500	40
FT6	853012500	80
FT7	855012500	160
FT8	857012500	240
FT9	861012500	400
FT10	863012500	480
FT11	867012500	640
FT12	868012500	680

When the radio is producing the DTMF tone, the mic audio is disabled. A dynamic regrouping chirp also sounds. This step is used to check DTMF deviation. The deviation level should be ±3.0 kHz to ±4.5 kHz.

3. Radio Disassembly

3.1 GENERAL

Remove the top cover to access the solder side of the RF board, personality board, and the power amplifier deck. Remove the top cover by turning the key to release the front handle and then press the button under the handle. The top cover pops up and allows access to the boards. Remove the screw that holds the PA deck cover to access the PA deck. This procedure provides access to the metering sockets of the RF board (J2501) and the PA deck (J1101) without removing the radio from its mounting tray.

Remove the radio from the chassis by releasing the handle as described above. Slide the radio forward (about an inch) and lift it out. Disconnect the cables to remove the radio from the chassis.

Note

Mounting screws for the common circuits board, personality board, and RF board are those with the black plastic captivators holding them to the boards.

Access the rest of the radio by removing the four screws that secure the skid plate to the bottom of the radio. Remove the skid plate to access the metering socket of the common circuits board (J951). The common circuits board is hinged so when turned on its hinge, it provides access to its component side as well as to the component side of the RF board. Remove the screws on the board and on the regulator heat sink to turn the common circuits board over on its hinge.

CAUTION

When operating the radio with the regulator head sink screw removed, care should be taken to avoid the exposed hot flange. All serviceable mounting screws use either Posi–drive heads which can be damaged by using standard Phillips screwdrivers. Use the proper screwdriver.

3.2 COMMON CIRCUITS BOARD

To turn the common circuits board on its hinges requires the removal of three screws. However, to remove the board, you must remove the two hinge screws, unplug the cable between the common circuits board and the personality board, and unplug the wires between the common circuits board and the PA deck. When installing the board in the radio, take care to pass both the cable and the wires between the two board hinges.

3.3 PERSONALITY BOARD

Remove the personality board from the radio as follows:

(1) Remove the seven screws that secure the board to the radio.

(2) Disconnect the cable from the front plug.

(3) Disconnect the 10 conductor cable from the common circuits board.

(4) Pull the board away from the radio to disconnect the connectors from the RF board.

When installing the board in the radio, be sure that the front plug gasket is properly seated. (Silicone compound, Motorola Part #11–00834678, can be helpful in this process.)

3.4 RF BOARD

Remove the RF board as follows:

(1) Remove the personality board as explained in paragraph 3.3.

(2) Remove the six retention screws.

(3) Disconnect the coaxial cable between the RF board and the internal casting.

(4) Disconnect the wires located near the antenna switch.

Access to some segments of the solder side of the RF board requires the removal of shields attached to the board with screws. On the component side of the RF board, remove the two large cans by simply pulling them off the board. However, other cans on the board must be unsoldered to be removed.

Install the RF board back in the radio using care to align the board guide posts with the internal casting. Take care to

match the board spring connectors with those of the internal casting.

3.5 INTERNAL CASTING

3.5.1 General

Remove the internal casting from the radio as follows:

(1) Remove three screws to allow the common circuits board to hinge.

(2) Remove four cover mounting screws from the bottom of the radio.

(3) Remove two screws from the RF board (from the other side of the radio).

(4) Disconnect the cable between the internal casting and the RF board.

(5) Disconnect the cable between the internal casting and the PA deck.

(6) Disconnect the RF board wires located near the antenna switch.

Exercise care during the reassembly operation to make the proper connections between the various connectors and to replace all the screws without omission.

3.5.2 First Mixer

To remove the first mixer, remove the two screws that secure the first mixer cover and gasket to the internal casting.

CAUTION

Do not use excessive heat. Otherwise, the tap leads will come off the filter.

Carefully unsolder the two tap leads from the first mixer to the filter and remove solder between the feed through and the circuit board. Remove the two screws that hold the circuit board to the internal casting, then remove the first mixer board.

3.5.3 Pre–amplifier

With the cover off, remove the pre–amplifier as follows: carefully unsolder and remove the tap lead from the two–pole filter, unsolder and disconnect the pre–amplifier coaxial cable, and disconnect the two insulated wires from the smaller pre–amplifier substrate.

CAUTION

See the Special Repair Procedures for soldering iron use on hybrid substrates. It is imperative that high silver content be used when removing the two insulated wires from the smaller pre–amplifier substrate. Since the smaller substrate is not copper clad, leaching of the pads can become a problem.

Remove the two screws that hold the carrier to the casting. Lift it out, using the handle that forms part of the carrier.

3.5.4 VCO Buffer/Doubler

Note

If the VCO assembly is replaced, it will be necessary to readjust the compensation level as explained in the Radio Adjustment Procedures in paragraph 2.

Remove the VCO buffer/doubler as follows: disconnect the coaxial cable to the VCO, disconnect the single wire to the feedthrough, disconnect the coaxial cable to the RF board, and disconnect the coaxial cable to the PA deck.

Remove the coaxial cables from the substrate, using the precautions explained in the Special Repair Procedures. Then, remove both cables from the internal casting. This may require the use of a larger soldering iron to heat the internal casting. However, never use the larger soldering iron on the substrate.

After removing the four mounting screws, the VCO buffer/doubler assembly can be removed by lifting the handle that forms part of the carrier. Lifting the carrier will simultaneously disengage the connector to the three–pole injection filter. This filter is located directly under the carrier.

3.6 TRANSMITTER PA DECK

Disassembly of the transmitter PA deck should be done on a module basis. It is strongly recommended that the entire module be replaced whenever it is found to be faulty. Removal of the hybrid modules requires removal of the horseshoe–shaped connector straps between the modules, the hold–down screws, and the A+ and A– leads. Do not fill the loop with solder since this would render the thermal expansion properties of the strap inoperative. See the Special Repair Procedures for instructions on removal and repair of these components.

3.7 FRONT LATCH

Remove the front latch key mechanism by inserting the key into the lock, turning the key about 45° in a clockwise direction, and inserting the special removal tool (Motorola Part #66–84909B01). Insert the tool with the point directed away from the lock while twisting it 180° in a clockwise

direction. This releases the key mechanism for removal. Removal of the black plastic part requires the removal of a single screw.

3.8 ANTENNA RELAY

Disconnect the wires to the coil and the connector on the RF board to remove the antenna relay. The coaxial cable to the internal casting can be unplugged at the casting, but the cable to the transmitter PA deck must be unsoldered at the harmonic filter. The antenna relay is secured by means of a nut located outside the radio chassis. Remove the nut with a spanner nut removal tool (Motorola Part #RSX4028A).

4. General System Troubleshooting Guide

4.1 GENERAL

Table 4 through Table 13 provide a general system troubleshooting guide. Table 4 is divided into three sections: symptoms of malfunction, possible cause of failure, and the procedure to be adopted to clear the fault.

The failure symptoms deal with the following conditions: absence of receive audio, distorted receive audio, low audio power. radio does not squelch, radio does not unsquelch, improper squelch sensitivity, no PL/DPL decode, no regulated 9.6 V or 5.0 V, no RF power output, low RF power output, no transmitter modulation, distorted transmitter modulation, improper microphone sensitivity, transmitter frequency shift with high–level modulation, synthesizer does not lock, reference frequency (6.25 kHz) heard in speaker or on transmitted audio, synthesizer locks on wrong frequency, slow synthesizer lock time, poor receive sensitivity, alternator whine.

4.2 REFERENCE

Depending on the cause of failure, the following troubleshooting charts and schematic diagrams are referred to for consultation:

- Schematic diagram of the audio section of the personality board; this diagram provides various voltage levels and waveforms and is located in the Microcomputer System section of this manual.
- Squelch troubleshooting chart; this is located in the Receiver section of this manual.
- Regulator troubleshooting guide; this is located in the Common Circuits Board section of this manual.
- Synthesizer troubleshooting chart; this is located in the Synthesizer section of this manual.
- Microcomputer troubleshooting chart; this is located in the Microcomputer System section of this manual.
- Power control troubleshooting chart; this is located in the Common Circuits Board section.
- Power amplifier troubleshooting chart; this is located in the Transmitter section.
- IDC troubleshooting chart; this is located in the Synthesizer section.
- Radio alignment and adjustment procedures; this is located in the General Maintenance section.
- Receiver troubleshooting chart; this is located in the Receiver section.

4.3 SYSTEM SELF CHECK

When the radio system is turned on it displays "SELF CHECK." During this time each processor does a diagnostic check. This includes checking ROM, RAM, EEPROMs, and serial bus circuitry. If no errors are detected, the display shows the selected mode. If there are any errors, they are displayed for two seconds each, after the self check display.

The error code is divided into two parts separated by a "/". The first part indicates the location of the error. The second part indicates the type of error. While the problem is not necessarily located on the board indicated by the location code, the troubleshooting guide for that board should be used to initially locate the problem. See Table 5 through Table 13 for interpretation of these codes.

There are two types of errors. The first type does not stop the system from operating. This error occurs if an option board is not communicating on the serial bus. In this case the display indicates "ERROR __/__." This specifies the error. When this display appears, the operator is alerted by a beep. The system continues to operate without the option.

The second type of error inhibits the operation of the system. This occurs if the radio's EEPROM is corrupted. Since the data needed to operate the radio is stored in the EEPROM (frequencies and PL codes) the system cannot work if that data is invalid. This type of error is indicated by a display of "FAIL __/__." If there is a single error of this type, the display shows it indefinitely. If there are multiple errors, and at least one of them is of this type, each error display is shown for two seconds and the display cycles through them.

A special case exists for error "FAIL 01/90." This error indicates the control unit did not receive a message from the radio. If this error occurs, the control unit resets the system after all the error displays are shown in an effort to correct the failure.

Table 4. General System Troubleshooting Guide

SYMPTOMS	POSSIBLE CAUSE	PROCEDURES
No Receive Audio	Red or green lead fuse	Check the fuses.
	Audio PA malfunction	See audio section of personality board schematic diagram.
	Regulator malfunction	See regulator troubleshooting chart.
	Synthesizer not locking	See synthesizer troubleshooting chart.
	Quad detector malfunction	See receiver section schematic diagram.
Distorted Receive Audio	Audio PA malfunction	See audio section of personality board schematic diagram.
	Quad detector malfunction	See receiver schematic diagram.
	IF malfunction	See receiver schematic diagram.
Low Audio Power	Audio PA malfunction	See audio section of personality board schematic diagram.
	Red lead fuse	Check fuse.
	Quad detector malfunction	See receiver schematic diagram.
	IF malfunction	See receiver schematic diagram.
No High–Speed or Low–Speed Data Encode	IDC malfunction	See IDC portion of common circuits schematic diagram.
	Trunking Controller	See Trunking schematic diagram and troubleshooting chart.
No Regulated 9.6V or 5.0V	Short on circuit board	—
	Regulator malfunction	See regulator troubleshooting chart.
No RF Power Output	PA enable switch	See microcomputer schematic diagram.
	Keyed 9.4V switch	See microcomputer schematic diagram.
	Synthesizer out–of–lock	See synthesizer troubleshooting chart.
	Red or orange lead fuse	Check fuse.
	Power control malfunction	See power control troubleshooting chart.
	PTT circuit malfunction	See troubleshooting serial data link and control unit. See the control unit and personality board schematic diagram.
	PA malfunction	See PA troubleshooting chart.
No Power Control	Power control malfunction	See power control troubleshooting chart.
Low RF Power Output	Power control malfunction	See PA troubleshooting chart.
	Antenna relay malfunction	See antenna relay test procedure.
No Transmitter Modulation	IDC malfunction	See IDC portion of the common circuits schematic diagram.
	Power control malfunction	See IDC portion of the common circuits schematic diagram.
	Microcomputer malfunction	See microcomputer schematic.
Distorted Transmitter Modulation	IDC malfunction	See IDC portion of common circuits schematic diagram.
	Reference oscillator malfunction	See IDC portion of common circuits schematic diagram.
	VCO malfunction	See IDC portion of common circuits schematic diagram.
Improper Microphone Sensitivity	IDC malfunction	See IDC portion of common circuits schematic diagram.
	VCO malfunction	See IDC portion of common circuits schematic diagram.
	Reference oscillator malfunction	See IDC portion of common circuits schematic diagram.
Transmitter Frequency Shift with High–Level Modulation	IDC malfunction	See IDC portion of common circuits schematic diagram.
Synthesizer does not Lock	Is radio scanning?	Out–of–lock LED lights if radio is scanning.
	Synthesizer malfunction	See synthesizer troubleshooting chart.
	Microcomputer malfunction	See microcomputer schematic.
Reference Frequency (6.25kHz) on transmitted audio or in speaker	Adaptive filter malfunction	See synthesizer troubleshooting procedure.
Synthesizer locks on wrong frequency	Synthesizer malfunction	See synthesizer troubleshooting chart.
	Microcomputer malfunction	See synthesizer troubleshooting chart.
	Reference oscillator Out–of–adjustment	See synthesizer troubleshooting chart.
Long Synthesizer lock time	Synthesizer malfunction	See synthesizer troubleshooting chart.
Poor receive Sensitivity	High IF malfunction	See receiver section schematic diagram.
	Low IF malfunction	See receiver section schematic diagram.
	Quad detector malfunction	See receiver section schematic diagram.
	Pre–amp malfunction	See receiver section schematic diagram.
	First mixer malfunction	See receiver section schematic diagram.
	Second mixer	See receiver section schematic diagram.
	Antenna relay malfunction	See antenna relay test procedure.
Alternator Whine	Chassis to A– short	Disconnect control cable and check for a short between chassis and A–.
	Excessive whine in vehicle	See manual number 68P81109E33.
No PL/DPL	Microcomputer malfunction	See microcomputer troubleshooting chart.
	IDC malfunction	See IDC portion of synthesizer troubleshooting chart.

Table 5. Radio Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 01/81 FAIL 01/84	Reprogram EEPROM or check J501/502. If "FAIL" shows after reprogram, replace U502.
FAIL 01/83 FAIL 01/85	Replace U501. Reprogram EEPROM or check J501/502. If "FAIL" shows after reprogram, replace U502.
FAIL 01/88	Replace U500.
FAIL 01/89	Replace U500 and U501.
FAIL 01/8A	Replace U500. Reprogram EEPROM or check J501/502.
FAIL 01/8C	If "FAIL" shows after reprogram, replace U502.
FAIL 01/8B FAIL 01/8D	Replace U500 and U501. Reprogram EEPROM or check J501/502. If "FAIL" shows after reprogram, replace U502.
FAIL 01/90 (Bus Failure)	Check cable kits. See Personality and Control Unit troubleshooting charts.

Table 6. Control Unit Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 05/82	Control Unit EEPROM corrupted. See Control Unit troubleshooting in this manual.
FAIL 05/84	Control Unit EEPROM blank. See Control Unit troubleshooting in this manual.
FAIL 05/90	Control Unit serial bus failure. See Control Unit troubleshooting in this manual.

Table 7. SECURENET*–Capable Radio Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 09/90 ERROR 09/10	Option serial bus failure. See the appropriate *SECURENET* instruction manual.

Table 8. Trunking System Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 10/82 ERROR 10/02	Option EEPROM corrupted. See the Trunking troubleshooting chart.
FAIL 10/84	Option EEPROM blank. See the Trunking troubleshooting chart.
FAIL 10/10	Option serial bus failure. See the Trunking troubleshooting chart.

Table 9. Siren/PA Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 08/10	Option serial bus failure. See the *Systems 9000* Siren/PA option instruction manual.

Table 10. MDC–600 *PTT ID or* MVS *Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0D/10	Option serial bus failure. See the appropriate instruction manual.

Table 11. MDC–600 *Full–Feature Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0A/10 ERROR 0B/10	Option serial bus failure. See the *MDC–600* Full–Feature option instruction manual.

Table 12. MDC–1200 *Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 0A/82	Option EEPROM corrupted. See the *MDC–1200* Signalling option instruction manual.
FAIL 0A/84	Option EEPROM blank. See the *MDC–1200* Signalling option instruction manual.
ERROR 0A/10	Option serial bus failure. See the *MDC–1200* Signalling option instruction manual.

Table 13. DTMF Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0E/10	Option serial bus failure. See the DTMF Option manual.
ERROR 0D/10	Option EEPROM failure. See the DTMF Option manual.

5. Antenna Switch Test Procedure

The antenna switch connects the antenna to the receiver via the receive reed, coaxial cable, and phono plug when the radio is in the receive mode. The antenna switch connects the antenna to the transmitter via the transmitter reed, coaxial cable, harmonic filter, and directional coupler when in the transmit mode.

5.1 TEST EQUIPMENT

A regular analog VOM is required for checking continuity paths or short circuits. See the list of recommended test equipment provided in Table 1 located in this section.

5.2 PROCEDURE

This procedure consists of the following two tests:

- receive signal path test,
- transmit signal path test.

As an initial step, disconnect the coaxial cable from the PA deck input. This allows the antenna switch to change from one condition to the other (i.e., from receive to transmit or vice versa) without causing the generation of PA output power.

5.2.1 Receive Signal Path Test

(1) Disconnect the receive cable plug from the internal casting socket. Using an ohmmeter, verify that continuity exists between the plug center pin and the antenna connector center pin. Verify that no continuity exists between the plug center pin and the plug shield (and/or radio chassis).

(2) Place the radio on a conventional mode or into the trunking test mode and key the radio. Under this condition, the receive reed opens. Verify that no continuity exists between the antenna switch center pin and the receive cable plug center pin.

5.2.2 Transmit Signal Path Test

(1) Verify that the coaxial cable is still disconnected from the PA deck input.

(2) Remove the PA shield.

(3) Key the transmitter and verify that continuity exists between the directional coupler input and the antenna switch center pin. If no continuity exists, check other points along the transmit signal path to locate any possible open circuits. (See Figure 2)

(4) Verify that the transmitter path to the radio chassis is not less than 100 K ohms.

Note

Field servicing of the antenna switch assembly or the microstrip harmonic filter is NOT recommended. A defective unit must be replaced.

(5) Key the transmitter and verify that continuity exists between the harmonic filter output and the antenna switch center pin. If continuity does not exist between these two points during transmitter keyed conditions, or if continuity exists during the receive mode, then the antenna switch assembly is defective and must be replaced.

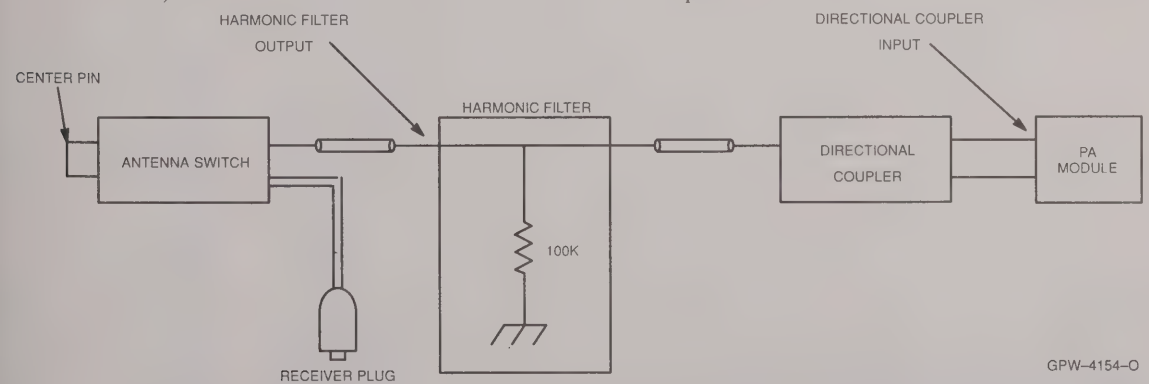

Figure 2. Transmit Signal Path

TOROLA RT NO.	DESCRIPTION
30230B03	internal casting housing (800 MHz)
5–84776M07	internal casting housing (UHF)
5–84776M01	internal casting housing (VHF)
30206B01	nylon grommet, 4 used
32002N01	tapping screw, 4.2 x 1.42 x 19mm; 4 used
32796H01	wire mesh gasket
	VCO substrate
30206B01	VCO cover
5–84817M01	VCO cover (VHF/UHF)
	VCO buffer substrate
33501M01	buffer cover
5–84851M01	buffer cover (VHF/UHF)
30208B01	mixer cover
5–84852M01	mixer cover (VHF/UHF)
84486M01	mixer gasket
2–80042D01	mixer gasket (VHF/UHF)
	mixer circuit board
	preamplifier circuit board
30207B01	preamplifier cover
5–84853M01	preamplifier cover (VHF/UHF)
10943C28	tapping screw, 3.5 x .6 x 6mm; 20 used
10943C34	tapping screw, 3.5 x .6 x 25mm; 4 used
30209B01	preselector cover, 6 cell
30210B01	preselector cover, 2 cell
30210B02	preselector cover, 3 cell
33894M01	preselector tuning cover
	VCO interconnect
	personality circuit board (solder side)
	personality circuit board (component side)
33503M01	retainer, 12 used
10943D29	tapping screw, 3.5 x .6 x 8mm; 19 used
10943D32	tapping screw, 3.5 x .6 x 16mm; 7 used
32001N02	tapping screw, 3.5 x .6 x 28mm; 2 used
33398M01	regulator heat sink
	common circuits board
33493M02	hinge, 2 used
00007652	#10 external lockwasher, 2 used
	RF circuit board, solder side
	RF circuit board, component side
34220B01	grommet, 12 used
34256M01	tapping screw, 12 used
33588M01	adaptive filter shield, solder side
33586M01	lower IF shield, solder side
33585M01	divider/phase detector shield, solder side
33587M01	quadrature detector shield, solder side
33594M01	can shield, component side, 7 used
33592M01	adaptive filter shield, component side
33593M01	divider/phase detector shield, component side
33597M01	prescaler shield, component side
33595M01	quadrature detector shield
33596M01	lower IF shield, component side, 4 used
33814M01	shield fence, component side
34282D01	male phono connector
34324M01	male connector, 2 contact
34324M02	male connector, 3 contact
33948M01	guide post, 2 used
33891L01	mixer clip, 5 used
34300B02	handle, 2 used
30134B02	speed clip, 10 used
	PA bus wiring
30158B01	cover lift spring
30172B01	spring clip, 2 used
30173B02	guide rail, 2 used
7–80173B03	guide rail, 2 used
7–80173B04	guide rail, 2 used
30208G03	mounting frame
30175B01	bottom cover gasket
30176B01	top cover gasket (p/o top cover assembly)
	directional coupler circuit board
30169B01	PA cover shield (800 MHz)
1–80244H02	PA cover shield (UHF)
1–80244H03	PA cover shield (Low Band)
5–84786M02	PA cover shield (VHF)
30723D66	feedthru plate assembly (PA)
30136B01	bus wire (top positive)
30137B01	bus wire (top negative)
30121B01	bus wire (bottom negative)
30120B01	bus wire (bottom positive)
33927M01	bus bar retainer
33927M02	bus bar retainer
33927M02	bus bar retainer
33927M04	bus bar retainer
30167B01	top bus clip
30201B01	bus wire clip
34093M01	solder lug, 6 used
33896M01	RF gasket
30124B01	harmonic filter cover
	harmonic filter substrate
33926M01	mesh gasket
33901M01	lower bus insulator
33897M01	wire receptacle terminal, 2 used
30107B01	handle
30152B01	handle pivot bracket, 2 used
33491M01	spring pin
30006A01	spanner nut
00114522	lockwasher
30080A01	ring gasket
	antenna switch
30154B02	cover release button

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
90	41–80155B01	cover release spring
91	42–80156B01	retainer ring
92	55–80157B01	cover release catch
93	75–00838826	rubber bumper
94	03–10943D48	tapping screw, 5 x .8 x 16mm, 2 used
95	55–84101B01	lock with key
96	15–80159B01	lock housing
97	55–80161B01	lock catch
98	41–80160B01	lock spring
99	15–80174B01	bottom cover
100	15–80105B02	radio housing (800 MHz)
	or 15–84763M02	radio housing (VHF/UHF)
102	42–10128A18	O ring, 5 used
103	01–80244J04	top cover assembly
104	03–10905A05	machine screw, 3 x .5 x 8mm, 15 used
105	03–10943D20	tapping screw, 3 x .5 x 8mm, 6 used
106	42–83982M01	cable clamp
107	——	power amplifier circuit board
108	——	metering circuit board
109	42–84367M01	wire hold–down clip, 2 used
110	——	final amplifier circuit board
111	——	driver circuit board
112	——	predriver circuit board
113	32–80219B01	front connector panel gasket housing
114	01–80726D99	front connector assembly, 37 contact
115	28–82647K02	10 contact male connector, 2 used
118	09–83445L09	10 contact female connector
119	30–80263K01	20 conductor cable (includes P401)
120	28–84647L04	right–angle, 6 contact connector
121	54–83895M01	radio label
123	04–84152B02	shoulder washer, 4 used
124	14–83820M02	transistor insulator, 4 used
125	26–83498M01	audio PA heatsink
126	03–82741M01	tapping screw, 3 x 8mm, 4 used
127	04–84180C01	shoulder washer
128A	15–84301K16	2 position connector housing
128B	39–82717M01	receptacle contact, 2 used
131	32–83997M01	feedthru gasket
132	75–82200H13	oscillator pad
133	75–82200H14	oscillator pad
134	14–84690M01	insulator
135	14–84690M02	insulator
136	14–84691M01	insulator
137	14–84691M02	insulator
144	30–83888P01	18 conductor flat cable (with DIP plugs)
145	04–00001719	flat metal washer
146	——	code plug with board
147	30–83776M01	14 conductor flat cable (with DIP plugs)
148	04–84345A12	flat plastic washer
149	01–80747T63	self Q assembly

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Exploded View, Mechanical Parts List, and Functional Block Diagram for *SYNTOR X 9000* and *SYNTOR X 9000E* Radios
PW–4345–B
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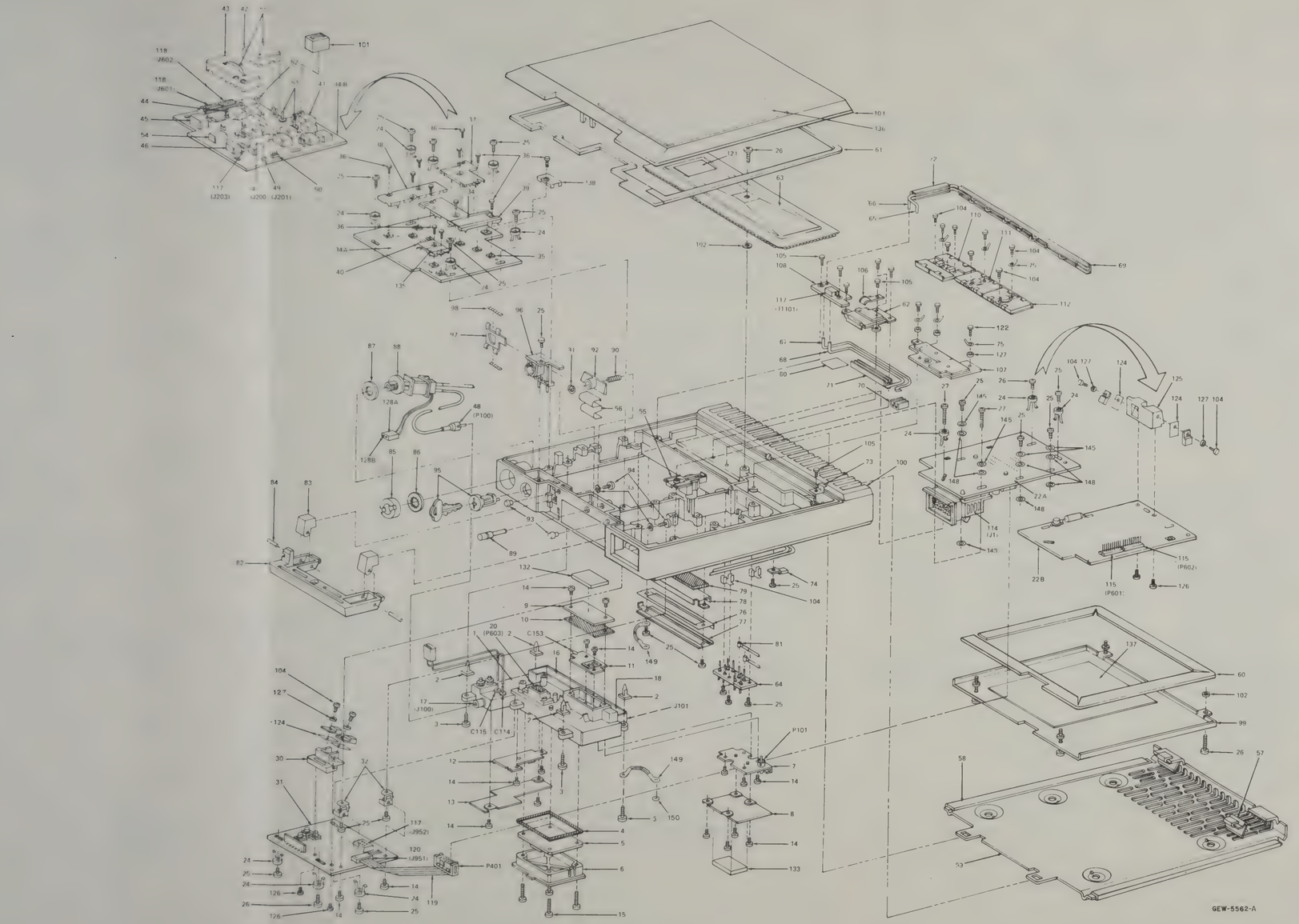

parts list

SYNTOR X 9000/SYNTOR X 9000E Radios Mechanical Parts MXW–5563–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15–80230B03	internal casting housing (800 MHz)
	or 15–84776M07	internal casting housing (UHF)
	or 15–84776M01	internal casting housing (VHF)
2	14–80206B01	nylon grommet, 4 used
3	03–82002N01	tapping screw, 4.2 x 1.42 x 19mm; 4 used
4	32–82796H01	wire mesh gasket
5	—	VCO substrate
6	15–80206B01	VCO cover
	or 15–84617M01	VCO cover (VHF/UHF)
7	—	VCO buffer substrate
8	15–83501M01	buffer cover
	or 15–84851M01	buffer cover (VHF/UHF)
9	15–80208B01	mixer cover
	or 15–84852M01	mixer cover (VHF/UHF)
10	32–84486M01	mixer gasket
	or 32–80042D01	mixer gasket (VHF/UHF)
11	—	mixer circuit board
12	—	preamplifier circuit board
13	15–80207B01	preamplifier cover
	or 15–84853M01	preamplifier cover (VHF/UHF)
14	03–10943C28	tapping screw, 3.5 x .6 x 6mm; 20 used
15	03–10943C34	tapping screw, 3.5 x .6 x 25mm; 4 used
16	15–80209B01	preselector cover, 6 cell
17	15–80210B01	preselector cover, 2 cell
18	15–80210B02	preselector cover, 3 cell
19	15–83894M01	preselector tuning cover
20	—	VCO interconnect
22A	—	personality circuit board (solder side)
22B	—	personality circuit board (component side)
24	42–83503M01	retainer, 12 used
25	03–10943D29	tapping screw, 3.5 x .6 x 8mm; 19 used
26	03–10943D32	tapping screw, 3.5 x .6 x 16mm; 7 used
27	03–82001N02	tapping screw, 3.5 x .6 x 28mm; 2 used
30	26–83398M01	regulator heat sink
31	—	common circuits board
32	55–83493M02	hinge, 2 used
33	04–00007652	#10 external lockwasher, 2 used
34A	—	RF circuit board, solder side
34B	—	RF circuit board, component side
35	05–84220B01	grommet, 12 used
36	03–84256M01	tapping screw, 12 used
37	26–83588M01	adaptive filter shield, solder side
38	26–83586M01	lower IF shield, solder side
39	26–83585M01	divider/phase detector shield, solder side
40	26–83587M01	quadrature detector shield, solder side
41	26–83594M01	can shield, component side, 7 used
42	26–83592M01	adaptive filter shield, component side
43	26–83593M01	divider/phase detector shield, component side
44	26–83597M01	prescaler shield, component side
45	26–83595M01	quadrature detector shield
46	26–83596M01	lower IF shield, component side, 4 used
47	26–83814M01	shield fence, component side
48	28–84282D01	male phono connector
49	28–84324M01	male connector, 2 contact
50	28–84324M02	male connector, 3 contact
51	46–83948M01	guide post, 2 used
52	42–83891L01	mixer clip, 5 used
53	55–84300B02	handle, 2 used
54	42–80134B02	speed clip, 10 used
55	—	PA bus wiring
56	41–80158B01	cover lift spring
57	41–80172B01	spring clip, 2 used
58	07–80173B02	guide rail, 2 used
	or 07–80173B03	guide rail, 2 used
	or 07–80173B04	guide rail, 2 used
59	07–80208G03	mounting frame
60	32–80175B01	bottom cover gasket
61	32–80176B01	top cover gasket (p/o top cover assembly)
62	—	directional coupler circuit board
63	26–80169B01	PA cover shield (800 MHz)
	or 01–80244H02	PA cover shield (UHF)
	or 01–80244H03	PA cover shield (Low Band)
	or 26–84786M02	PA cover shield (VHF)
64	01–80723D66	feedthru plate assembly (PA)
65	30–80136B01	bus wire (top positive)
66	30–80137B01	bus wire (top negative)
67	30–80121B01	bus wire (bottom negative)
68	30–80120B01	bus wire (bottom positive)
69	52–83927M01	bus bar retainer
70	52–83927M02	bus bar retainer
71	52–83927M02	bus bar retainer
72	52–83927M04	bus bar retainer
73	42–80167B01	top bus clip
74	42–80201B01	bus wire clip
75	29–84093M01	solder lug, 6 used
76	32–83896M01	RF gasket
77	15–80124B01	harmonic filter cover
78	—	harmonic filter substrate
79	32–83926M01	mesh gasket
80	14–83901M01	lower bus insulator
81	29–83897M01	wire receptacle terminal, 2 used
82	55–80107B01	handle
83	07–80152B01	handle pivot bracket, 2 used
84	22–83491M01	spring pin
85	02–80006A01	spanner nut
86	04–00114522	lockwasher
87	32–80080A01	ring gasket
88	—	antenna switch
89	38–80154B02	cover release button

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
90	41–80155B01	cover release spring
91	42–80156B01	retainer ring
92	55–80157B01	cover release catch
93	75–00838826	rubber bumper
94	03–10943D48	tapping screw, 5 x .8 x 16mm, 2 used
95	55–84101B01	lock with key
96	15–80159B01	lock housing
97	55–80161B01	lock catch
98	41–80160B01	lock spring
99	15–80174B01	bottom cover
100	15–80105B02	radio housing (800 MHz)
	or 15–84763M02	radio housing (VHF/UHF)
102	42–10128A18	O ring, 5 used
103	01–80244J04	top cover assembly
104	03–10905A05	machine screw, 3 x .5 x 8mm, 15 used
105	03–10943D20	tapping screw, 3 x .5 x 8mm, 6 used
106	42–83982M01	cable clamp
107	—	power amplifier circuit board
108	—	metering circuit board
109	42–84367M01	wire hold–down clip, 2 used
110	—	final amplifier circuit board
111	—	driver circuit board
112	—	predriver circuit board
113	32–80219B01	front connector panel gasket housing
114	01–80726D99	front connector assembly, 37 contact
115	28–82547K02	10 contact male connector, 2 used
118	09–83445L09	10 contact female connector
119	30–80263K01	20 conductor cable (includes P401)
120	28–84647L04	right–angle, 6 contact connector
121	54–83895M01	radio label
123	04–84152B02	shoulder washer, 4 used
124	14–83820M02	transistor insulator, 4 used
125	26–83498M01	audio PA heatsink
126	03–82741M01	tapping screw, 3 x 8mm, 4 used
127	04–84180C01	shoulder washer
128A	15–84301K16	2 position connector housing
128B	39–82717M01	receptacle contact, 2 used
131	32–83997M01	feedthru gasket
132	75–82200H13	oscillator pad
133	75–82200H14	oscillator pad
134	14–84690M01	insulator
135	14–84690M02	insulator
136	14–84691M01	insulator
137	14–84691M02	insulator
144	30–83888P01	18 conductor flat cable (with DIP plugs)
145	04–00001719	flat metal washer
146	—	code plug with board
147	30–83776M01	14 conductor flat cable (with DIP plugs)
148	04–84345A12	flat plastic washer
149	01–80747T63	self Q assembly

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Exploded View, Mechanical Parts List, and Functional Block Diagram for *SYNTOR X 9000* and *SYNTOR X 9000E* Radios

PW–4345–B

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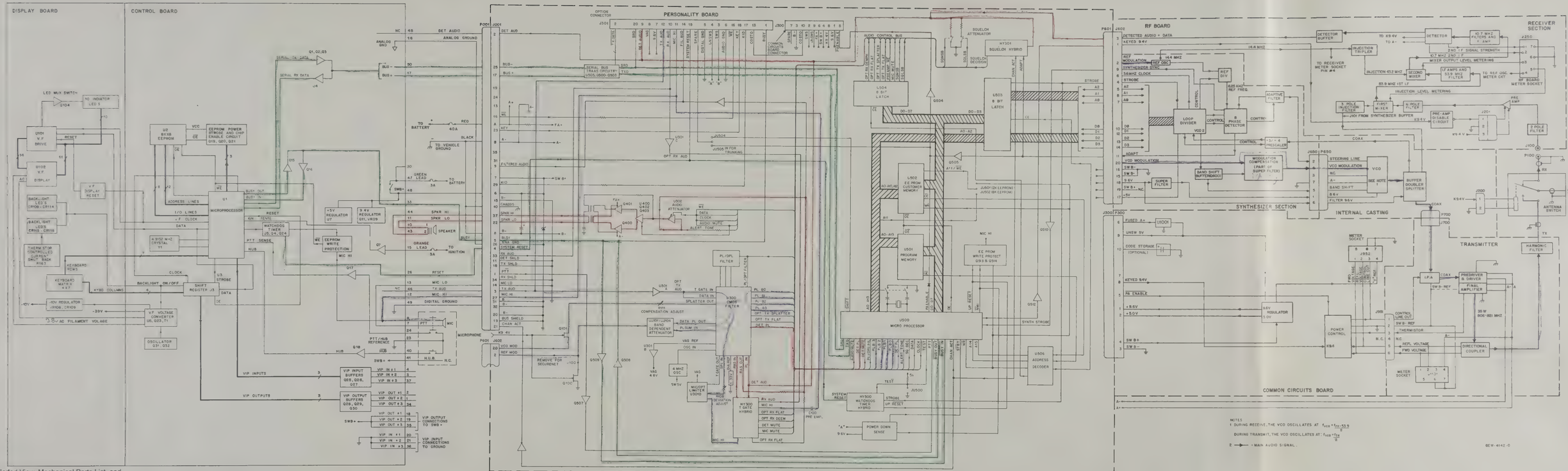

Exploded View, Mechanical Parts List, and
Functional Block Diagram for *SYNTOR X 9000*
and *SYNTOR X 9000E* Radios
PW–4345–B
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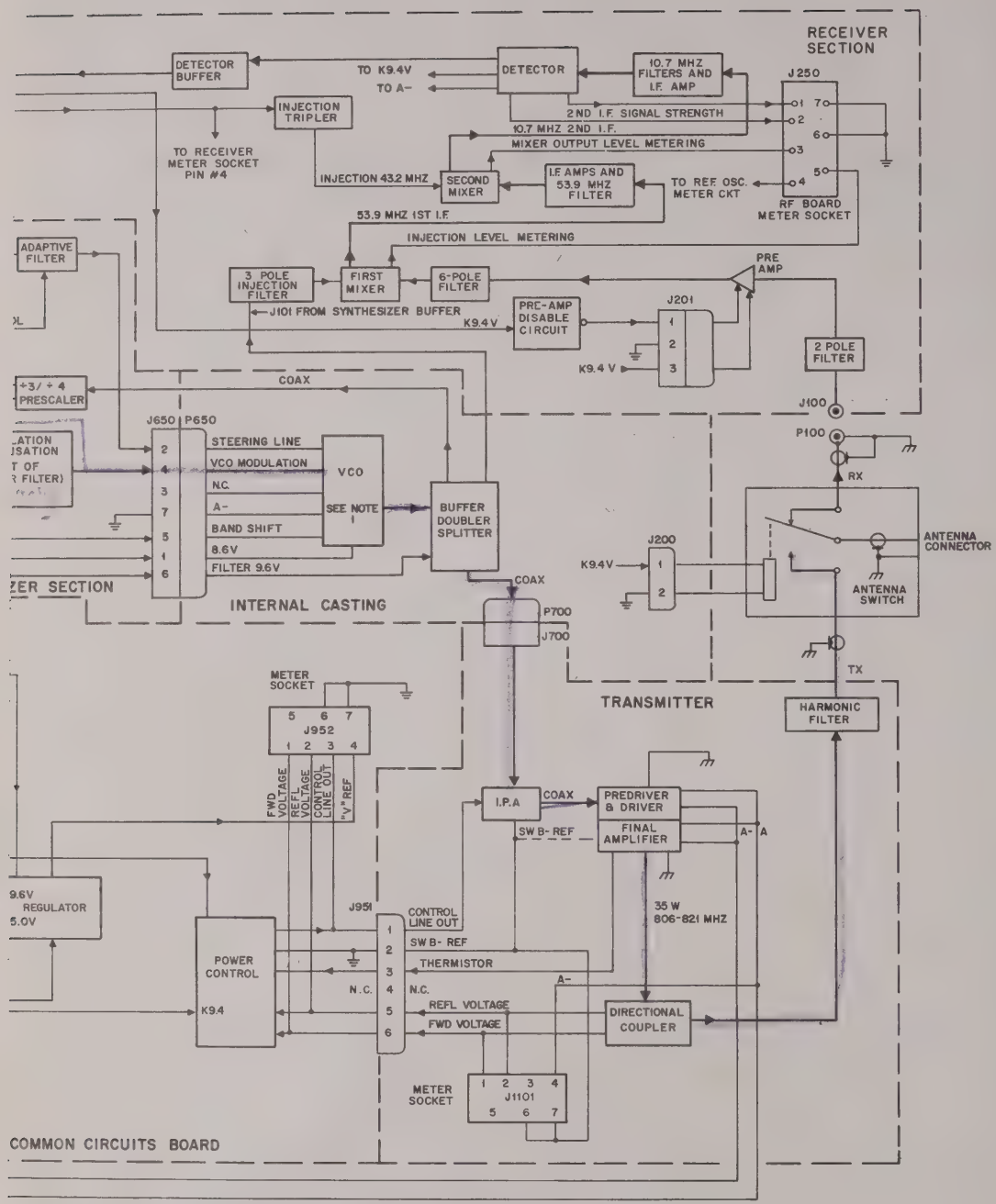


'E, THE VCO OSCILLATES AT: $f_{vco} = \frac{f_{rx} - 53.9}{n}$

MIT, THE VCO OSCILLATES AT: $f_{vco} = \frac{f_{tx}}{2}$

I AUDIO SIGNAL.

GEW-4142-O

1. Ceramic Microstrip Substrates

You should not attempt to repair the ceramic microstrip substrates of the radio. If a module has a faulty component, replace the whole module. Not only are repairs to the substrates and replacements of substrate components difficult to make without damaging the module, but also the factory uses special fixtures in building and testing the radio to make certain that each module operates properly. Field repairs to the microstrip substrates negate that initial factory adjustment.

The ceramic materials of the radio have properties similar to those of glass, and sharp blows and heat affect them the same way they affect glass. Therefore, if you must solder anything to ceramic microstrip modules, use as little heat and pressure as possible. You must also use solder with a high percentage of silver to avoid leaching the capacitors and non–copper runners.

2. Chip Capacitors

The radio uses many chips capacitors as circuit elements. They are extremely sensitive to heat and must not be re–used. Be very careful when making repairs to circuits near these components. Heat from a soldering iron being applied to a nearby component may "leach" the end metalization (terminals) of a chip capacitor. Figure 1 shows what a leached capacitor looks like.

To remove a chip capacitor, apply heat to both connecting terminals simultaneously, either with two soldering irons or a single iron with a special tip (Motorola #ST–1160). When the connecting solder melts, lift the chip. Figures 2 and 3 illustrate this removal technique.

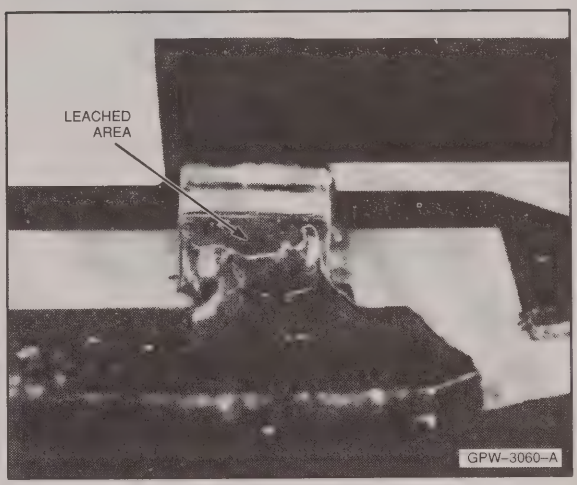


Figure 1. "Leached" Chip Capacitor

3. Replacing Transistors in the Power Amplifier

To remove the power transistors, remove two transistor mounting screws or one stud nut (accessible from the chassis bottom). Unsolder and remove the clamped mica capacitors, then unsolder an remove the transistors. Special soldering iron tips ST1160 and ST1161 (available form Motorola parts offices) make it easier to remove capacitors and transistors.

When replacing RF power transistors, you must take the following steps. First, use a soft cloth or paper towel to remove all thermal compound and residue from *both the chassis and the transistor*. Then apply a thin film of Wakefield thermal compound to the bottom of the transistor mounting flange. Replace the transistor in the center of the printed circuit board cutout, tightening the mounting hardware to a maximum of 7 inch–pounds. With a low power soldering iron (40–60W), solder the leads, using enough solder to completely cover the lead and solder pad. Make sure that the solder is flowing freely both *over* and *under* the lead before

removing the heat. If a lead tends to spring away from the circuit board, use the tips of a pair of pliers to hold the far end of the lead down against the board until the solder hardens. After replacing the transistors, replace the clamped mica capacitors, being sure to position them exactly as they were with respect to the transistor body.

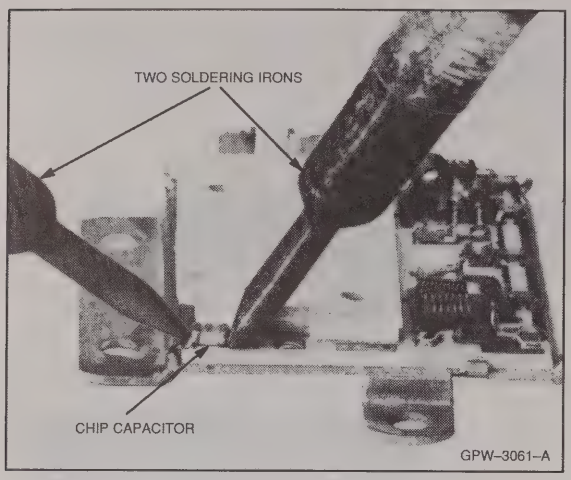


Figure 2. Capacitor Removal with Two Soldering Irons

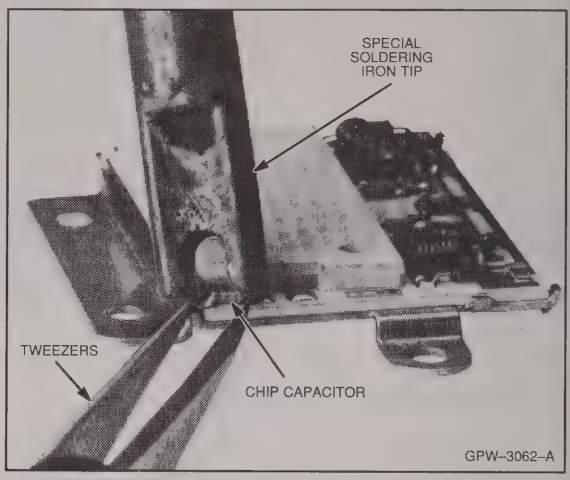


Figure 3. Capacitor Removal with Special Soldering Tip

Microcomputer System (Radio)

1. General

This section covers the Microcomputer System section of your radio.

2. Theory of Operation

2.1 INTRODUCTION

The *SYNTOR X 9000* personality board consists of two major sections; the digital section, and the analog section. The digital section is notated by the 500 series part designators. The analog section is notated by the 100, 200, 300, and 400 series part designators.

2.2 DIGITAL SECTION

The digital section communicates with the control head and the options over a serial bus link to receive and transmit information. This section also monitors parallel inputs from the radio. The digital section microprocessor uses both serial bus inputs and radio parallel inputs, to decide response to and control of the system. The digital section controls the radio since it controls the parallel outputs.

The outputs are controlled to perform various functions including:

- Audio routing.
- Synthesizer programming.
- Transmitter enables.
- Audio volume level control.
- PL and DPL detection.
- PL and DPL generation.
- Squelch level control.
- Alert tone generation.

The major blocks in the digital section are:

- U500—microprocessor.
- U501—program ROM.
- U502—customer system/mode EEPROM.
- U503—synthesizer programming latch.
- U504—audio control latch.
- U506—address decoder.
- HY500—watchdog timer hybrid.
- U505 and supporting circuitry–serial bus transceiver.

2.3 ANALOG SECTION

The personality board analog section contains all the non–RF analog circuitry in the radio, with the exception of the voltage regulators and the RF power control. The analog section circuitry is grouped by circuit designators as follows:

- 100 series transmit audio circuitry.
- 200 series receive audio circuitry.
- 300 series circuitry common to receive and transmit.
- 400 series audio power amplifier.

The analog section provides various audio and sub–audio filtering, summing, and amplifying functions that include:

- Receive audio switching.
- Transmit audio switching.
- Microphone pre–emphasis and deviation limiting.
- VCO compensation adjustment.
- Discriminator de–emphasis filtering.
- Received PL/DPL filtering and detection.
- PL/DPL D/A converter and filtering (PL/DPL generation).
- RF carrier detect/undetect (squelch).
- Digitally controlled audio attenuator.
- Audio power amplifier.
- Option receive and transmit summing/buffering.

The major blocks of the analog section are:

- U300—custom switched capacitor filter IC.
- 4 MHz crystal controlled oscillator (clocks U300).
- U301—quad opamp; microphone pre–emphasis/limiter; option RX and TX summer/buffer; biasvoltage buffer.
- HY300—audio switching hybrid.
- HY301—squelch hybrid.
- U302—pre–amplifier (digitally controlled attenuator).
- 400 series designator parts– audio power amplifier.
- Jumper selections.

3. Detailed Circuit Description

3.1 DIGITAL SECTION

3.1.1 Microprocessor System

The microprocessor (U500) with the program ROM (U501), the programmable EEPROM (U502), address decoder (U507), and output latches (U503 and U504) make up the microprocessor system.

The heart of the system is the high–speed CMOS microprocessor that runs at 1.2288 MHz. The processor uses Y500, a 4.9152 MHz crystal, for its time base. This oscillator is internally divided by four at the processor to obtain its operating frequency of 1.2288 MHz.

3.1.2 Address Decoding (U506)

The microprocessor controls the address lines, A14 and A15 output WR, to gain access to U501, U502, U503, and U504. The processor does this through the address decoder U506. The three inputs to U506 on Pins 2, 14, 3, 13, and 15 control U506 outputs to Pins 6, 7, 9, and 11. These signals, zero to five volt logic levels, are active low. When U506–6 is low, the processor is accessing U502 (EEPROM). When U506–7 is low, the processor is accessing U501 (program PROM). When U506–9 is low, U504 is accessed, and with U506–11 low, U503 is accessed.

3.1.3 Program Memory (U501)

The program that the processor executes is contained in the 16k by 8 UV–EEPROM. By manipulating the remaining 14 address lines (A13–A0), the processor can read the instructions stored permanently in the EEPROM. The address lines A14 and A15 are used for address decoding.

3.1.4 Customer Mode EEPROM (U502)

All radio mode information is stored in U502 (EEPROM). The standard EEPROM is 2k by 8 in a 24–pin package. This package is inserted in the rear 24 pins of the IC socket (Pins 1, 2, 27, and 28 are left open). The board design accepts an optional 8k by 8 EEPROM that is a 28–pin part. The EEPROM is reprogrammable, and is read from like the program memory IC (U501). It is also written to by the EEPROM programming mode, described later.

3.1.5 Synthesizer Programming Latch (U503)

The synthesizer programming latch is an eight–bit static latch whose outputs store the digital value (high or low) of its inputs when a low to high transition occurs on U503–11. To load data into the synthesizer, the latch stores correct data (D3–D0) from the customer mode EEPROM, and the corresponding address (A2–A0) with the strobe output high (U503–19). Then the latch stores the same address and data with the strobe output low. This clocks the four bits of data into the synthesizer. For valid programming to occur, this process is repeated for five sets of data with five different addresses. The synthesizer is continually updated to avoid corrupted data passing on a power supply transient condition. The update rate is approximately every 20 milliseconds.

3.1.6 Audio Control Latch (U504)

The audio control latch operates in the same manner as the synthesizer programming latch (U503). In addition, the audio control latch provides signals for five audio routing paths, both squelch level controls, and a control line for audio volume programming.

3.1.7 Watchdog Timer Hybrid (HY501)

The watchdog timer hybrid performs three functions. This hybrid circuit controls the system reset line, monitors the internal microprocessor reset line, and senses the system reset line.

The first function is performed on power–up of the radio system. The hybrid outputs a reset pulse approximately 30 milliseconds long to allow the crystal oscillators in the system to stabilize. The pulse is high on system reset (HY500–10).

Secondly, the watchdog timer monitors its input. The synthesizer strobe from U503–19 should toggle every 20 milliseconds. If the strobe pulse fails to toggle, the watchdog timer times out and initiates a 30–millisecond reset pulse. This is a failsafe in the event the radio's microprocessor gets lost due to a power supply transient.

The third function performed by the watchdog timer hybrid is its sensing of the system reset line. This line is bi–directional. If another processor in the system gets lost due to a transient, that processor initiates a reset pulse to recover. If the system reset line is pulsed, the watchdog timer stretches the pulse to a 30–millisecond reset pulse.

3.1.8 Serial Bus Transceiver (U505 and supporting circuitry)

Communication between processors in the system is handled by the serial bus at a data rate of 9600 bits per second. The signals generated are bus +, bus –, and busy. Bus + and bus – carry the same serial data. Bus – is bus + inverted (bus + high, bus – low). In using this pair of signals, the comparator U505 can differentiate between noise and valid data. In normal radio transmission, the radio microprocessor reads the line busy in (U500–9). If found to be HI, the processor pulls busy out high (busy in active LO, busy out active HI), and transmits as message out of TX data (U500–13). To further avoid a

collision on the serial bus, the radio processor reads serial RX data (U500–12) as it transmits. If the processor does not read back the same data that it sent out, some error occurred and the radio processor attempts to re–transmit the message. When receiving a transmission, (example: control head transmitting), the radio processor would sense busy in (U500–9) going LO and process the incoming message from serial RX data (U500–12).

3.1.9 EEPROM Programming

The EEPROM (radio mode information) is programmed by communication over the serial bus. Special commands are sent to and from the radio microprocessor from the IBM PC programmer interface.

Note

An IBM PC and Control Head/Radio Programming Software Version 3.0 (or later) are required to program this radio.

The EEPROM is equipped with an input called "write–enable" that is active LO (LO writes to the EEPROM). This input is at U502–23 for a 2k by 8 EEPROM or at U502–27 for an 8k by 8 EEPROM. To protect the contents of the EEPROM from being inadvertently written over, the write–enable line is held in active by the microphone HI audio input.

The line is protected to eliminate the possibility of corrupting the EEPROM data during power supply transients or other temporary battery supply conditions that could possibly alter the data. The microphone HI audio input is normally biased up to 9.6 volts while receiving, and pulled to approximately 4 volts when transmitting to power the active element microphone cartridge. When connected to either of the programmers, the microphone input is shorted to ground and allows access to the EEPROM write–enable line.

The microphone line is input to the digital section by R530 pulling the base of Q513 HI and forcing Q513 to pull the base of Q514 LO. With Q514 conducting, the input write–enable (U502–23 for 2k by 8 and U502–28 for 8k by 8) is held HI by Q514. Note that CR502 and CR503 protect the write–enable line in the same manner. The diode CR502 protects the EEPROM write line the instant the radio loses power (switched off) since this signal senses when the 9.6 volt supply falls off. The diode CR503 protects the EEPROM when the system is being reset due to power supply transients.

3.1.10 Power Down Sequence

With the power off, the radio microprocessor is put in its sleep mode. This mode requires to cut back the current drain on the unswitched five–volt regulator from 15 milliamps to a few micro–amps. The unswitched five–volt regulator remains powered up while the radio is off so that the radio microprocessor retains its memory and powers up in the last mode used. The radio processor retains the last mode, volume level, squelch level, and other operator–selected functions.

This eliminates the need for resetting all the controls every time the radio is turned on. For the radio processor to remember its last configuration, inputs are required that allow the processor to store this information be fore power is shut off to its memory and supporting circuitry (switched five volts turning off). The inputs NMI and STBY are generated to tell the processor that power is coming down.

The signals NMI and STBY are generated by the transistor circuits involving Q516 and Q517. Both signals are active LO, so when NMI is LO, the processor is put in the sleep mode (standby). The transistor Q516 remains off while the 9.6–volt supply is powered up. This is done through R542 that pulls the base of Q516 HI. When the 9.6 volt supply begins to fall off (radio is turned off), Q516 begins to conduct, since its emitter is connected to the unswitched five–volt supply (this supply remains powered). As Q516 begins to conduct, the base of Q517 is pulled HI, and the collector is pulled LO. The collector is connected to U500–8, the NMI input to the processor. The signal STBY is generated by the R–C circuit made by R547 and C521. This signal goes LO approximately 500 microseconds after the NMI signal goes LO. The STBY input is at U500–7.

3.1.11 Test Mode

The radio test mode allows finer audio volume steps to be input to the audio preamp. In standard operation, you can set volume in 30 discrete steps. These steps increment the audio level by approximately 3.2 dB. In the test mode, increments are approximately .4 dB. This allows setting the volume closer to rated audio, more accurately setting the audio volume level, and measuring receive parameters such as RX audio distortion, received FM hum and noise, squelch sensitivity, and other receive parameters.

Enter the test mode by shorting the two pins of jumper JU500, and turn the radio on. The radio processor reads this input (U500–21). By shorting this input, the processor reads this port LO, enters the test mode, and enables the finer volume increments. Jumper JU503 also disables the watchdog timer. This is useful for troubleshooting. If a malfunction causes the watchdog timer to time out, the timer sends out reset pulses until the system recovers. By shorting JU500, the reset pulses stop and the system resumes operation. This allows you to troubleshoot and find the source of a problem with out resetting the system.

3.2 ANALOG SECTION

The analog section of the personality board consists of four groups of circuitry. They are transmit audio, receive audio, common circuitry, and the audio power amplifier.

3.2.1 Transmit Audio Circuitry

To handle hardware options more efficiently, there are three possible paths for audio to pass through while transmitting. The first, the normal microphone path, follows the standard pre–emphasis curve of +20 dB per decade from 300 Hz to 3 kHz, and rolls off sharply at frequencies above 3 kHz.

The second two transmit–audio routing paths are available for hardware options. Both of these paths are accessed through the option TX buffer at J301–12 or J1–3. The input at

J301–12 provides for options internal to the radio, and J1–3 provides for options in the external options box. This input is the null port of the opamp U301–1. The input allows summing of multiple option outputs without interference.

The first transmit audio route is TX splatter. This port, when enabled, displays a flat response from 300 Hz to 3 kHz, and rolls off sharply at frequencies above 3 kHz.

The other transmit route available to the options is TX flat. This port shows a flat response from approximately 2 Hz to above 6 kHz, and does not roll off sharply.

3.2.2 Microphone Transmit Audio

The microphone path enters the radio through J1–27. The resistors R101 and R102 with the capacitor C108 provide DC bias for the active microphone element. This signal is available as an input to the options at J301–11.

Microphone HI, after entering the radio, goes to C100. This capacitor blocks DC, and sets the pre–emphasis required to an 18–kHz high–pass corner. The high–pass filter provides the required +20 dB/decade pre–emphasis response. The microphone path is switched in or out by the transmission gate on HY300. The signal is input at HY300–6 and output at HY300–4. The control line to turn the microphone path on is at HY300–11, and microphone mute is active HI. HY300–6 and HY300–4 are the summing node of the opamp unless the path is open (HY300–11 HI).

The microphone signal is amplified by U301 by a factor of 24 (at 1 kHz), so the nominal 80 mV input from the microphone almost sends the opamp output into clip. A slightly stronger signal causes the output to clip. The signal can never be greater than the output swing of the opamp. The output of the opamp is attenuated by the deviation potentiometer R108. This adjustment is used to set deviation of the overall system to below 5 kHz.

After the microphone signal has been pre–emphasized, limited, and the level set through R108, the signal enters the splatter filter at U300–11. The splatter filter provides the sharp roll–off required to frequencies above 3 kHz. The output of the splatter filter (at U300–13) travels to the compensation potentiometer R111. The compensation potentiometer is used to adjust the sensitivity of the VCO modulation port to equal the reference modulation port.

The VCO modulation port response has a high–pass response, and the reference modulation port has a low–pass response. The compensation potentiometer sets the sensitivity of the VCO modulation port so that the overall response of the VCO is flat.

The correct tuneup procedure is to set the compensation potentiometer (R111) first, and then set the deviation potentiometer (R108).

Then the audio signal travels through the series FET (Q101) to the RF board where it is input to the VCO circuitry to modulate the RF carrier during transmit. The series FET (Q101) provides isolation to the VCO mode line during the VCO's receive mode of operation.

3.2.3 Option Transmit through Splatter

This option path is one of two paths that a hardware option is able to route audio to be transmitted. The path is enabled by the latch U504 from Pin 6. In normal operation, the port is enabled when the option sends a command over the serial bus. The radio processor then enables the port and keys the radio. The option (for example PTT–ID) enables its audio port to send an audio signal into TX audio. This audio signal is amplified by the opamp U301–A. The output of U301–A at U301–3 appears at the switch input on U300–9. The switch on U300 functions as an analog transmission gate.

The switch control is at U300–10, and closes the switch when this input is low. The output of this switch is at U300–14. Once routed through this switch, the signal is input to the same limiter opamp used by the microphone path (U301–D). The signal is amplified to almost clip the output at nominal levels (just as the microphone path), but it is not pre–emphasized. The output of the opamp follows the same path as the micro phone path: through the deviation limit potentiometer, through the splatter filter, and then to the VCO modulation port through the compensation potentiometer.

3.2.4 Option Transmit Flat

This is the second of the TX audio paths available to the hardware options. It is enabled by commands over the serial bus in the same manner as the option transmit through splatter path. This port is enabled by the output of the latch U504–5.

This audio port is named the flat TX port due to the extended response it provides. The flat TX port displays a flat frequency response from approximately 2 Hz to above 6 kHz. This response is required for digital signaling schemes such as the *SECURENET* option.

The audio for this path is input from the option the same as the TX splatter path (through U301–A). In this case, the splatter port is not enabled (the switch on U300–14 is open), and the flat port is enabled. The switch enables when the control at U300–22 is high. The audio input to the switch is at U300–21, and the output is at U300–15. The IC provides +7.5 dB of gain from input to output, and also sums with the IC's internal D/A converter.

The D/A converter is used to generate PL and DPL transmit signals with the data lines D3 through D0 at Pins 32, 31, 30 and 29 of U500. These outputs of the processor drive the inputs of the D/A on U300 at Pins 25, 26, 27, and 28. The D/A on U300 requires the reference voltage at U300–1 to function properly. The reference voltage is a resistive divider, formed by R307 and R308, and provides the required 1.3 volts DC to this input. The output of the D/A is at U300–15. As discussed above, the D/A is summed with the TX flat path.

PL and DPL are used only when the microphone path or the option TX through the splatter path are enabled. The only signal present at U300–15 is a TX flat signal or a PL/DPL, but not both. The output of U300–16 is normally 500 mV above

the analog ground voltage (Vag) at U300–7. The output, when generating PL or DPL, swings symmetrically about this normal voltage (Vag + 500 mV). The output at U300–15 follows the same paths as those described in the TX flat path section, and the signal is input to both the VCO modulation input and the reference modulation input to the RF board.

The output of the TX flat switch (U300–15) is routed to two different inputs to the VCO. The first is the VCO modulation port, and the second is the reference modulation port.

The TX flat signal routing to the VCO modulation port is from the output of the TX flat switch (U300–15). The signal is attenuated by R116 and R117. The attenuated signal is input to U300–8. The input is summed internally with the splatter filter input, and is output at U300–13. This summing node allows PL or DPL to be summed with normal audio from the micro phone path, and, in this case, allows the TX flat audio to reach the VCO modulation port. The output of U300–13 travels to the VCO modulation port via the compensation adjust potentiometer. The TX flat signal routing to the reference modulation port is through resistive attenuators. The jumpers JU101, JU102, JU103, and JU104 select the proper attenuation required for low–band, VHF, UHF, and 800–MHz bands respectively. The TX flat signal passes through the DC blocking capacitor C105, and then to the reference modulation port. The transistor Q100 shunts the reference modulation port to ground when the radio is powered up, and allows the VCO to lock more quickly when first powered up.

Due to the high deviation required by *SECURENET*, the transistor Q100 is removed from the circuit by removing JU100 on *SECURENET* model radios. If not removed from the circuit, the transistor Q100 begins to conduct, and distorts the signal.

3.2.5 Receive Audio Circuitry

There are four paths in the receive audio circuitry for audio output through the speaker. These paths are the discriminator path, the option through receive audio filter path, the option through flat response path, and the alert tone path.

The discriminator path is the recovered audio output from an RF signal at the antenna input. This path exhibits a –20 dB/decade response from 300 Hz to 3 kHz. The response falls off sharply with frequencies below 300 Hz and above 3 kHz.

The Personality Board provides two inputs in the receive audio path for hardware options for the receive audio string. First is RX through received audio shaping that follows the same response as the discriminator path, –20 dB/decade from 300 Hz to 3 kHz. Second is the RX flat that displays frequency response from 200 Hz to 10 kHz. The final path in the receive audio string is the alert tone path. This path allows the radio microprocessor to sound alert tones through the speaker.

3.2.6 Discriminator Audio

The discriminator audio path is input to the personality board from the RF board via P601–3. The discriminator path is then input to the transmission gate hybrid (HY300) through C201. C201 provides DC blocking. The input to HY300 is at HY300–7, and the output is at HY300–8. The control line for disc mute is controlled by the output of U500–26. The control line is input to HY300–11, and is active HI (HI mutes the audio). The output of HY300–8 inputs to the receive audio shaping filter on U300. The receive audio shaping filter input is at U300–20, and is not switched. An input between 300 and 3 kHz always causes an output at U300–17. The filter provides the standard de–emphasis response of –20 dB/decade from 300 to 3 kHz. The received audio shaping filter provides band–pass filtering. The pass band is approximately 270 Hz to 3.5 kHz. The filter exhibits a loss of –3 dB at 1 kHz.

The radio microprocessor decodes received PL or DPL, and determines if the proper code is present. The radio bases this decision on its input from the comparator on U300. The discriminator output from the RF board (P601–3) is input to the PL/DPL filter on U300 through C200. Input to the PL input filter is at U300–19. The PL filter has a low pass response, and changes its response when the selected mode is a PL mode or a DPL mode. The PL filter, when input PL/DPL is low (PL response), rolls off at approximately 250 Hz. When on a DPL mode (U300–23 is high), the PL filter rolls off at approximately 150 Hz. The output of the PL filter (U300–16) is averaged by R205 and C209 for PL, and R205 and C210 for DPL. The DC averaged signal is input to the negative input of the comparator on U300. The negative input is at U300–4 and the positive input is at U300–5. The PL filter output connects to the positive input of the comparator. This causes the output of the comparator (U300–3) to swing high when a positive going signal is output from the discriminator. The comparator output swings low when the discriminator output has a negative going signal. The output of the comparator attenuates by R208 and R209, and is read by the processor input at U500–24.

The output of the receive audio shaping filter inputs to the audio preamp (U302) through the audio summing node via R200. The audio summing node consists of R200, R201, R202, R203, and C202. The summing node provides attenuation for the receive audio shaping path, RX flat path, and the alert tone input. The summing node inputs to the audio pre–amplifier U302–15. The preamp is a digitally–controlled, variable gain buffer whose gain can vary from –70 to +18 dB. The gain is controlled by U500 and U503 through the control lines, UCS data, UCS write–enable, and UCS clock. The preamp gain is programmed with a serial data stream that controls the volume. The serial data appears on the UCS data line, and is clocked in bit by bit by the UCS clock when write–enable is low. The preamp has another control to force its output to mute at U302–13. The mute line is an output of U500–25, and is active LO (LO mutes the preamp). The output of U302 next feeds into the audio power amplifier through C400 that blocks DC. The audio power amplifier is a class A/B amplifier stage, and runs approximately 200 milliamps of bias to the collectors of final output transistors (Q400 and Q401) while idling with no audio input. The audio power amplifier provides +34 dB of gain and presents an

output impedance of 8 ohms to drive an 8–ohm speaker. At the nominal battery voltage of 13.8 volts, the power amp delivers over 15 watts of power with total harmonic distortion below 3%.

3.2.7 Option Play through Receive Audio Shaping

The first option path available to the hardware options is RX through receive audio shaping filter or RX–RAS. The internal options access the RX audio ports through J301–10, and the options residing in the external options box access the RX audio ports through J1–33. Both RX audio ports, RX–RAS and RX flat, are enabled in the same manner as TX audio ports, by commands over the serial bus.

The RX audio signals are input through J301–10 and/or J1–33, and are summed and buffered by the option RX buffer opamp U301–C. The input is the null port at U301–8, and allows options access without interference. The output of the option RX buffer is connected to two inputs to HY300.

The input at HY300–9 is the input for RX–RAS. The control input for RX–RAS is at HY300–2, and comes from the output of U504–2. The control is active low (HI when the switch is open). With the control low, the RX–RAS enables, and the signal output drives the input of the receive audio shaping filter. The signal path follows the same path as the discriminator audio path discussed earlier.

3.2.8 Option Play Flat Response

The option play flat response is input to the option RX buffer, the same as the option play through RAS. The option RX buffer output (U301–10) connects to the RX flat switch (HY300–9). This switch is controlled by U504–5, and is active low (HI when the switch is open). The control line input to the hybrid is at HY300–13. When enabled (closed), the RX option buffer connects directly to the audio summing node by R201. The summing node sets the correct attenuation for the input to the audio pre–amplifier. The remainder of the path is the same for the discriminator audio path.

3.2.9 Alert Tones

The alert tones are generated by the radio microprocessor by toggling its output at U500–15. This output is AC coupled by C208, and is summed directly into the audio summing node through R202.

3.2.10 Power Amplifier

The power amplifier is biased to 5.0 volts at its positive input by resistors R400 and R401. The dual output opamp U400 drives the pre–driver transistors (Q403 and Q402). The outputs of the opamp are approximately 2.1 volts apart, and U400–4 is higher than U400–1. The banded transistor pairs, Q403 and Q402, are graded NPN pairs and graded PNP pairs respectively. The pairs are graded to match base to emitter voltage drops. This transistors Q403–A and Q402– A form a current mirror into transistors Q403–B and Q402–B. The current is fixed through Q403–A and Q402–A by resistor R406.

When unmuted transistor Q404 is conducting, the bias current is higher than when muted. The mirrored current through Q403–B and Q402–B provides the base drive for the final output 6 transistors. The DC feedback for the opamp U400 comes from the tap between R407 and R408. The feedback DC biases the entire feedback winding of the transformer (Pins 7, 8 of T400). The transformer input windings (Pins 1, 6; Pins 2, 5) are driven by the final output transistors Q401 and Q400 respectively. The output winding of the transformer is routed from J1–37 and J1–22 in the radio, through the cable kit, into the control head, and finally to the speaker.

3.3 SUPPORT CIRCUITRY COMMON TO RECEIVE AND TRANSMIT

Supporting circuitry appears throughout the analog section of the personality board. All of the 300 series designators provide functions such as supply by–passing, etc. Two of the supporting sections are worthy of special note, the 4–MHz oscillator and the analog ground buffer opamp.

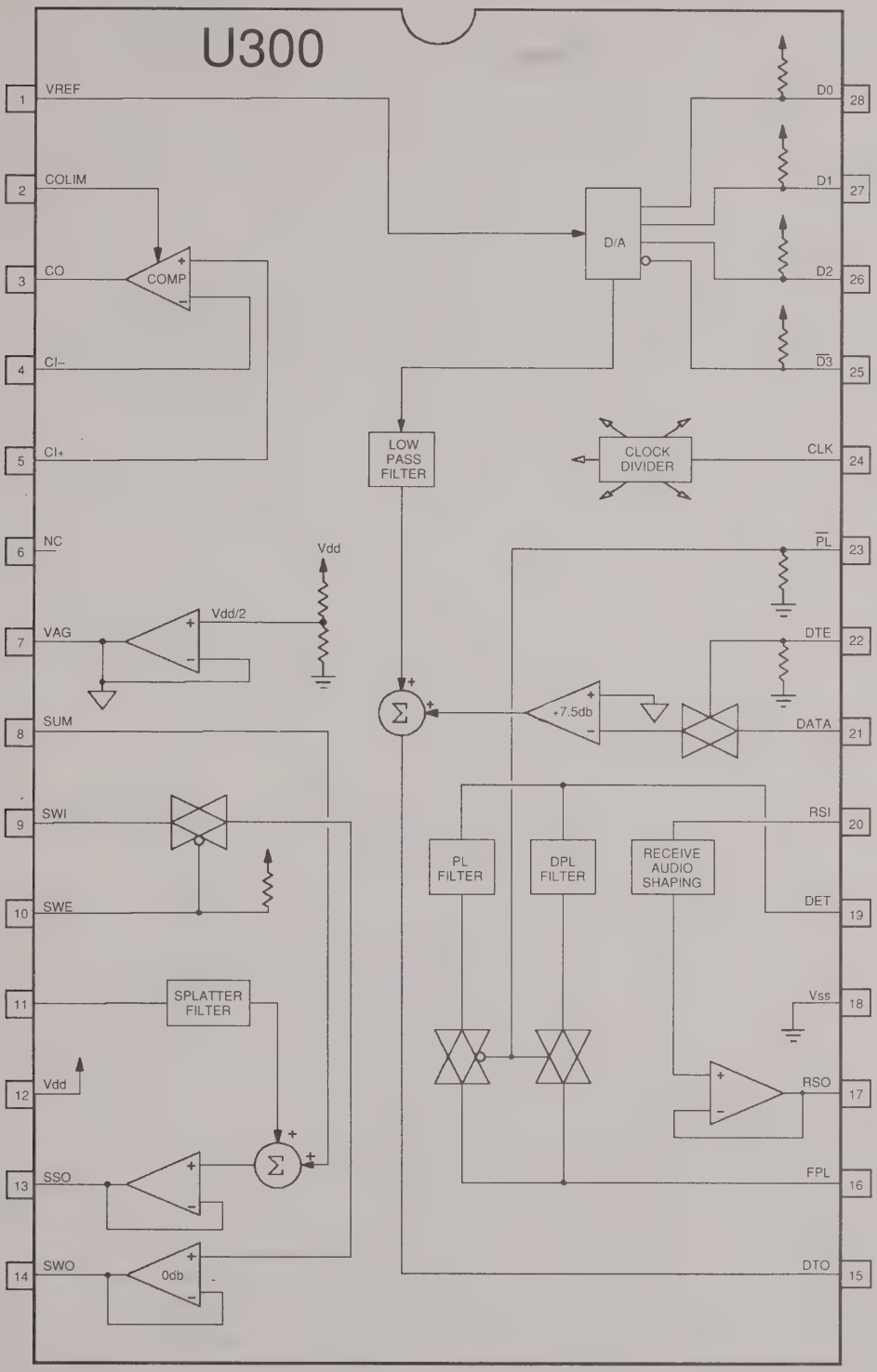
3.3.1 Oscillator (4–MHz)

The linear crystal oscillator provides the switched capacitor filter IC (U300) with its clocking rate. The oscillator provides a 4–MHz sine wave (distorted) at an amplitude of approximately 700 mV peak–to–peak to the clock input (U300–24). The oscillator uses Q300 and Y300 to produce the signal.

3.3.2 Analog Ground Voltage Buffer

The opamp U301–B is a unity gain voltage follower. The opamp output buffers the output of the Vag reference output (U300–7). IC U300 biases internally to approximately half of its 9.6–volt supply. To reduce audio transients when switching an audio path in or out, the buffered analog ground voltage biases all audio circuitry except the audio power amplifier. The analog ground voltage is presented to the internal hardware options via J301–8, so the options can use this DC potential to bias their analog circuitry.

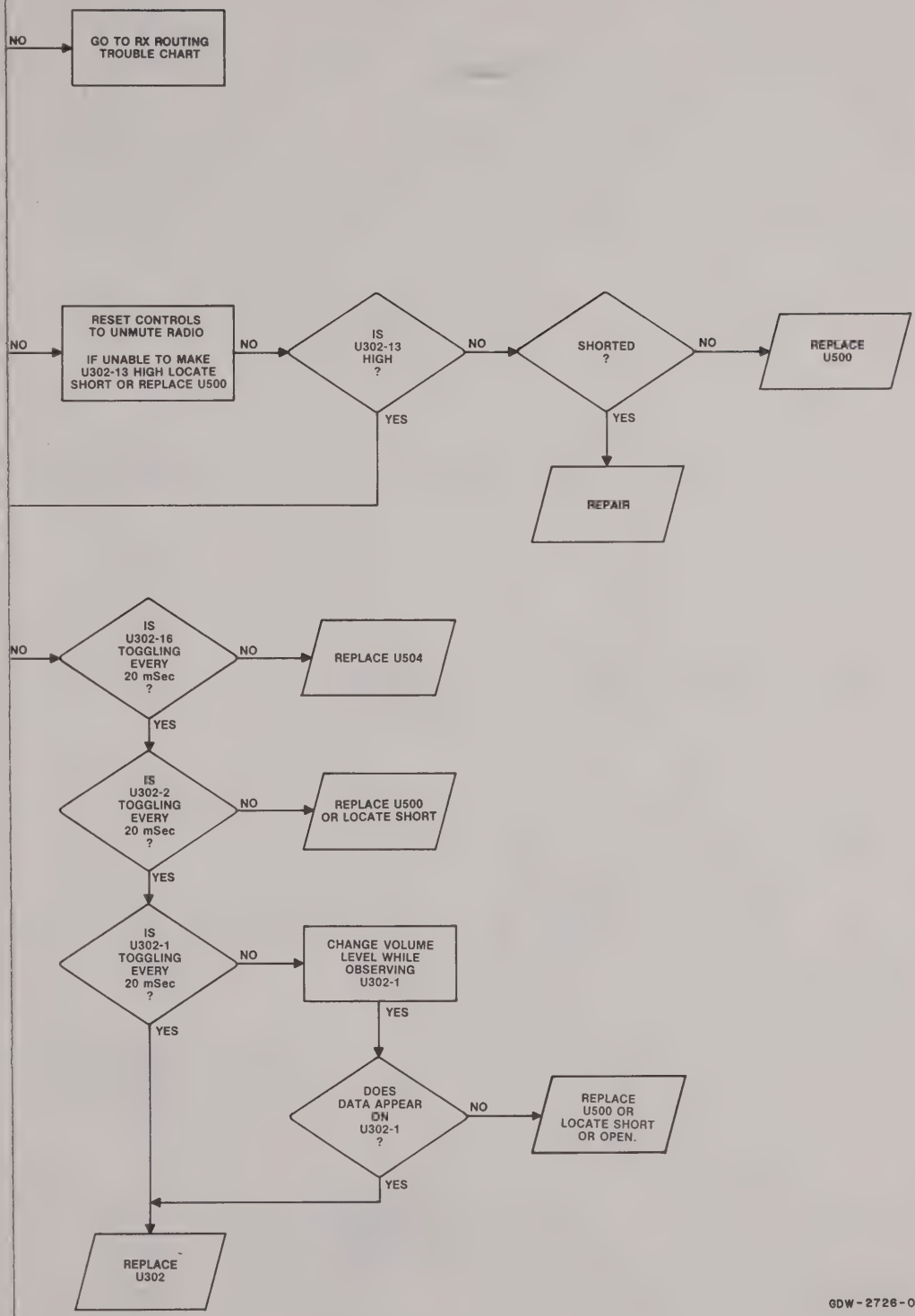
U300 BLOCK DIAGRAM



GPW–2585–A

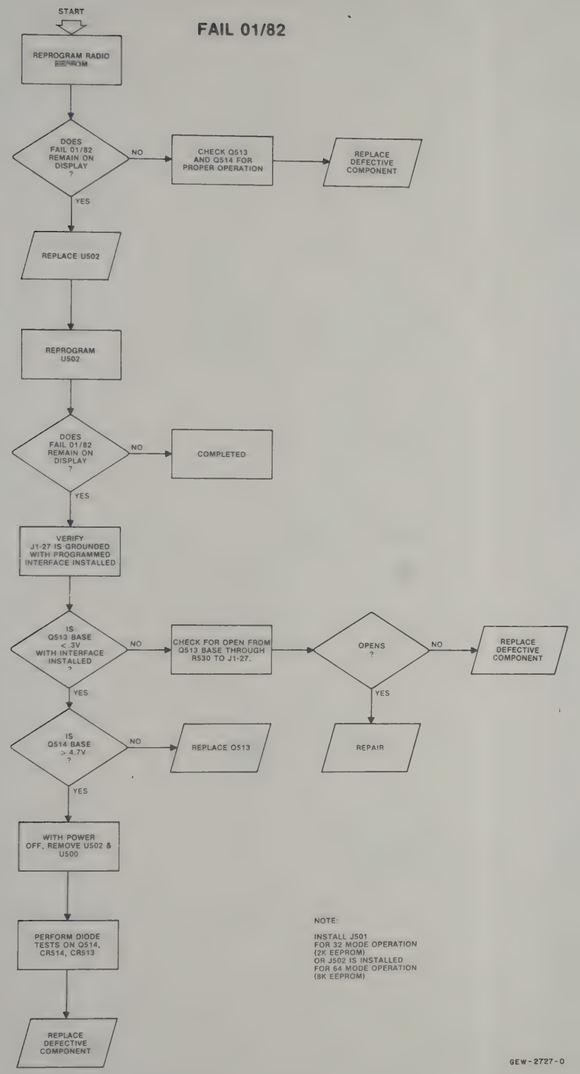
U300 Functional
Block Diagram
PW–4552–A
8/30/88

AUDIO PREAMP FAILURE



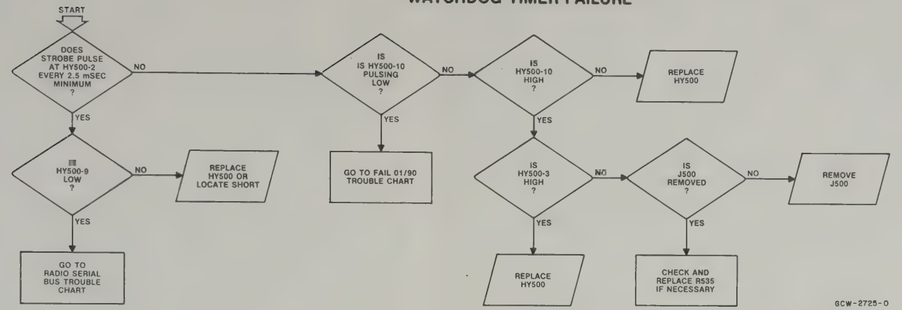
Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 1 of 4)
5/10/88

FAIL 01/82



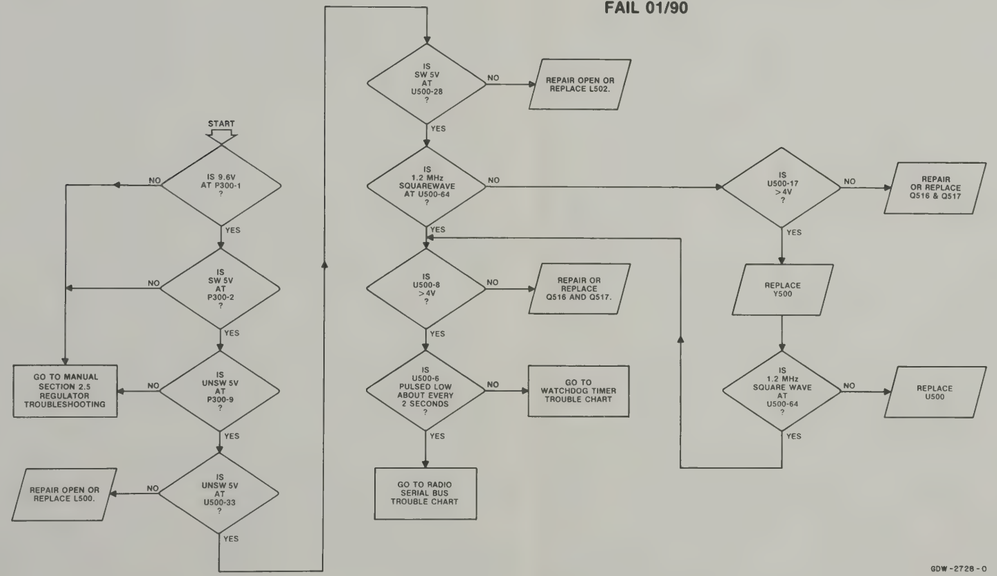
GEW-2727-0

WATCHDOG TIMER FAILURE



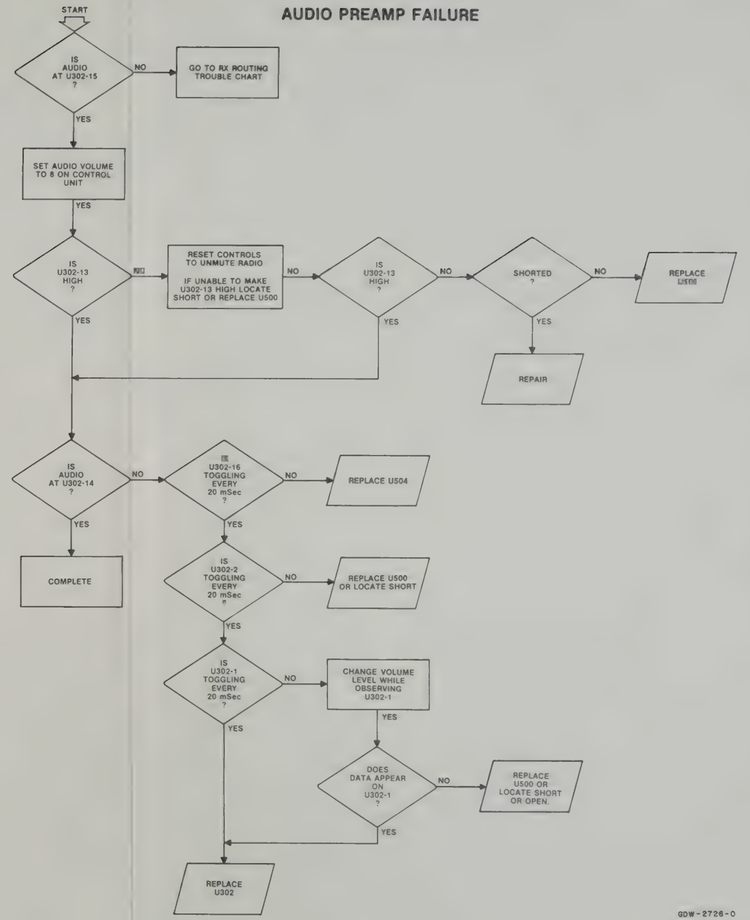
GCW-2725-0

FAIL 01/90



GDW-2728-0

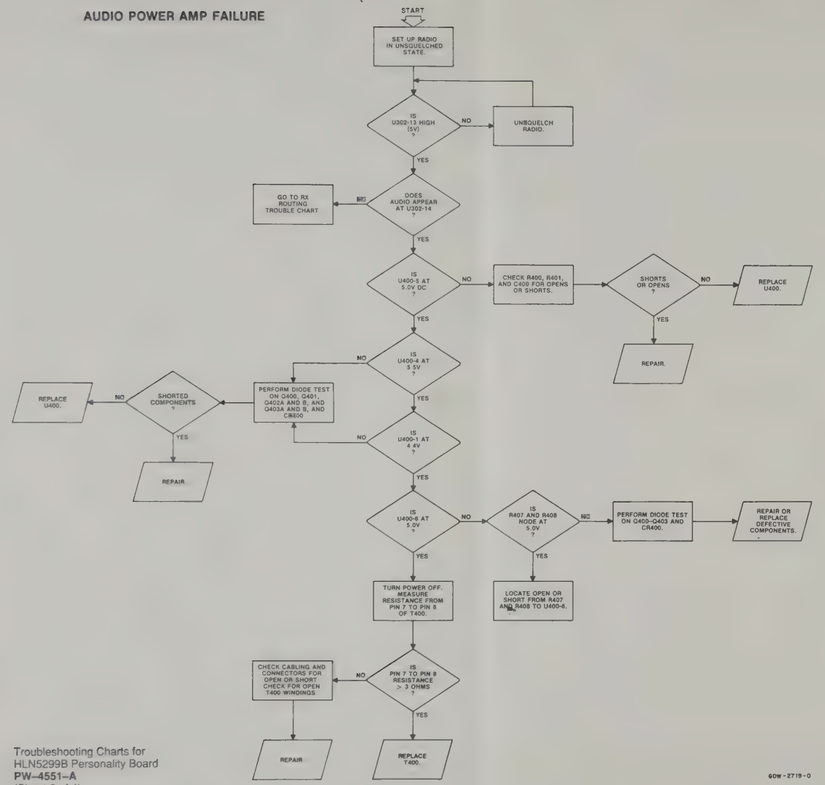
AUDIO PREAMP FAILURE



GDW-2726-0

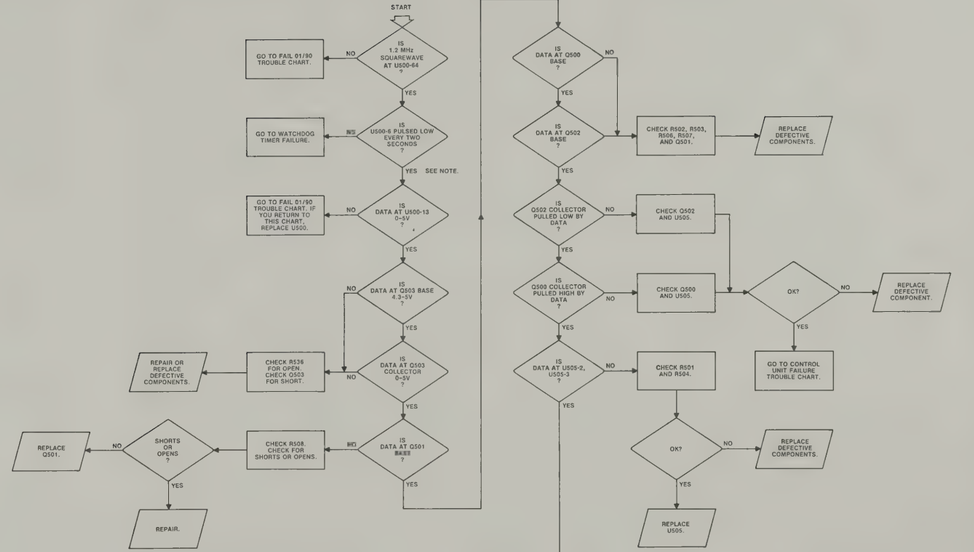
Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 1 of 4)
5/10/88

AUDIO POWER AMP FAILURE

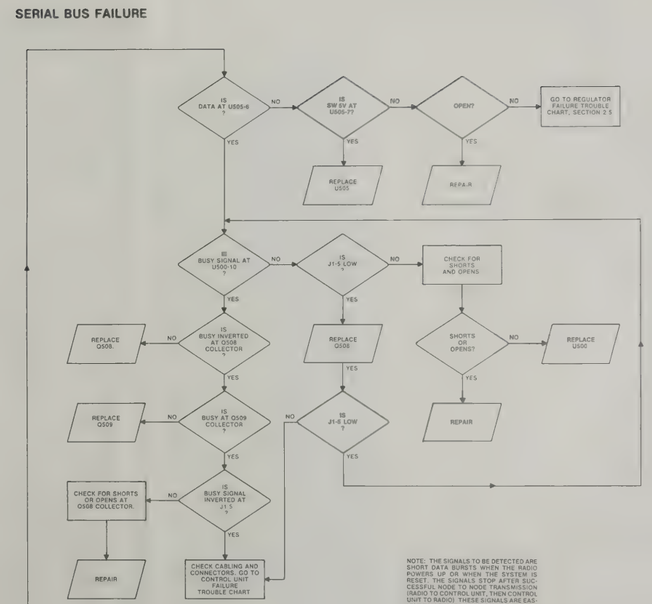


GDW-2719-D

Troubleshooting Charts for
HLN5299B Personality Board
PW-4551-A
(Sheet 2 of 4)
5/10/88

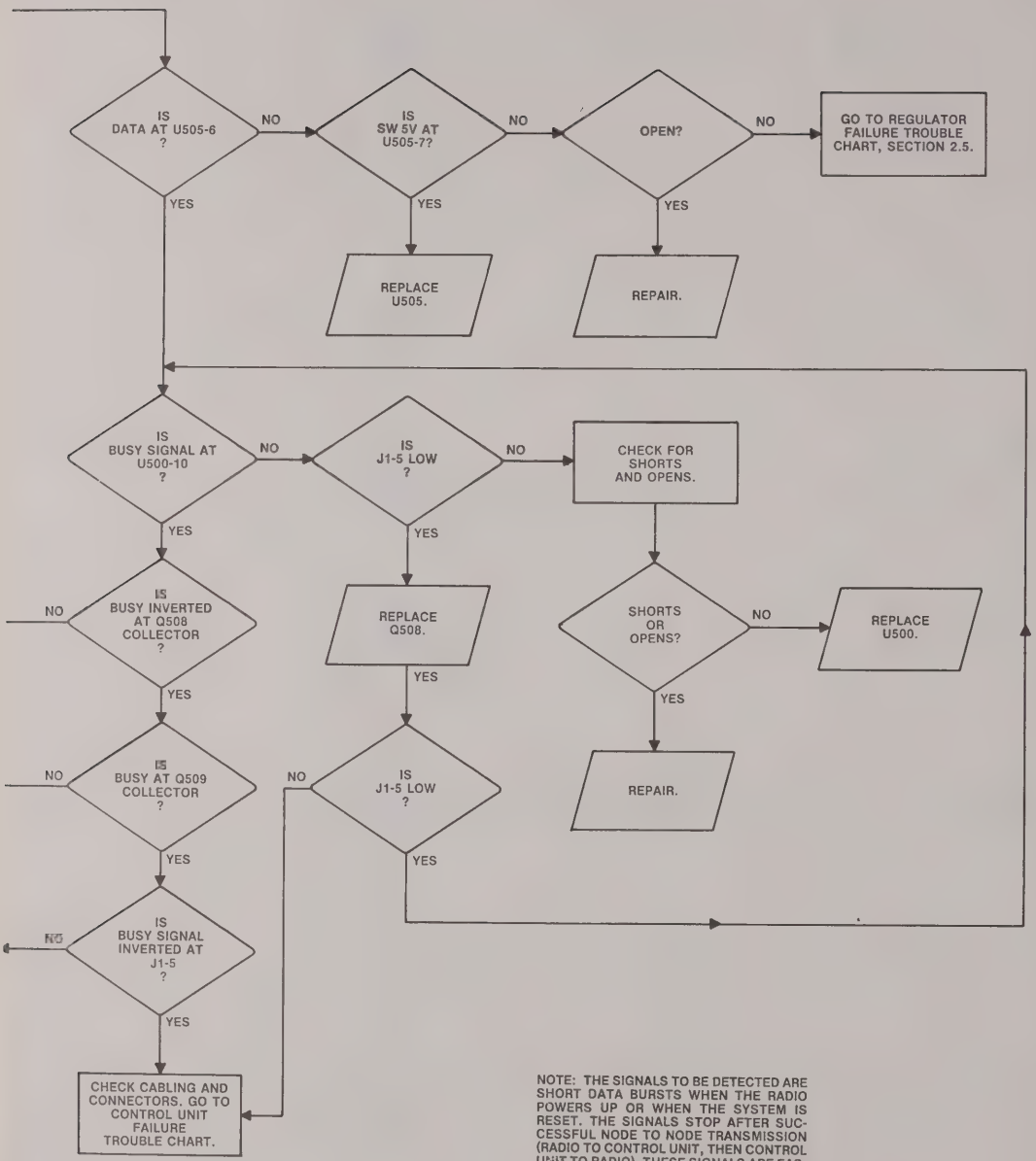


SERIAL BUS FAILURE



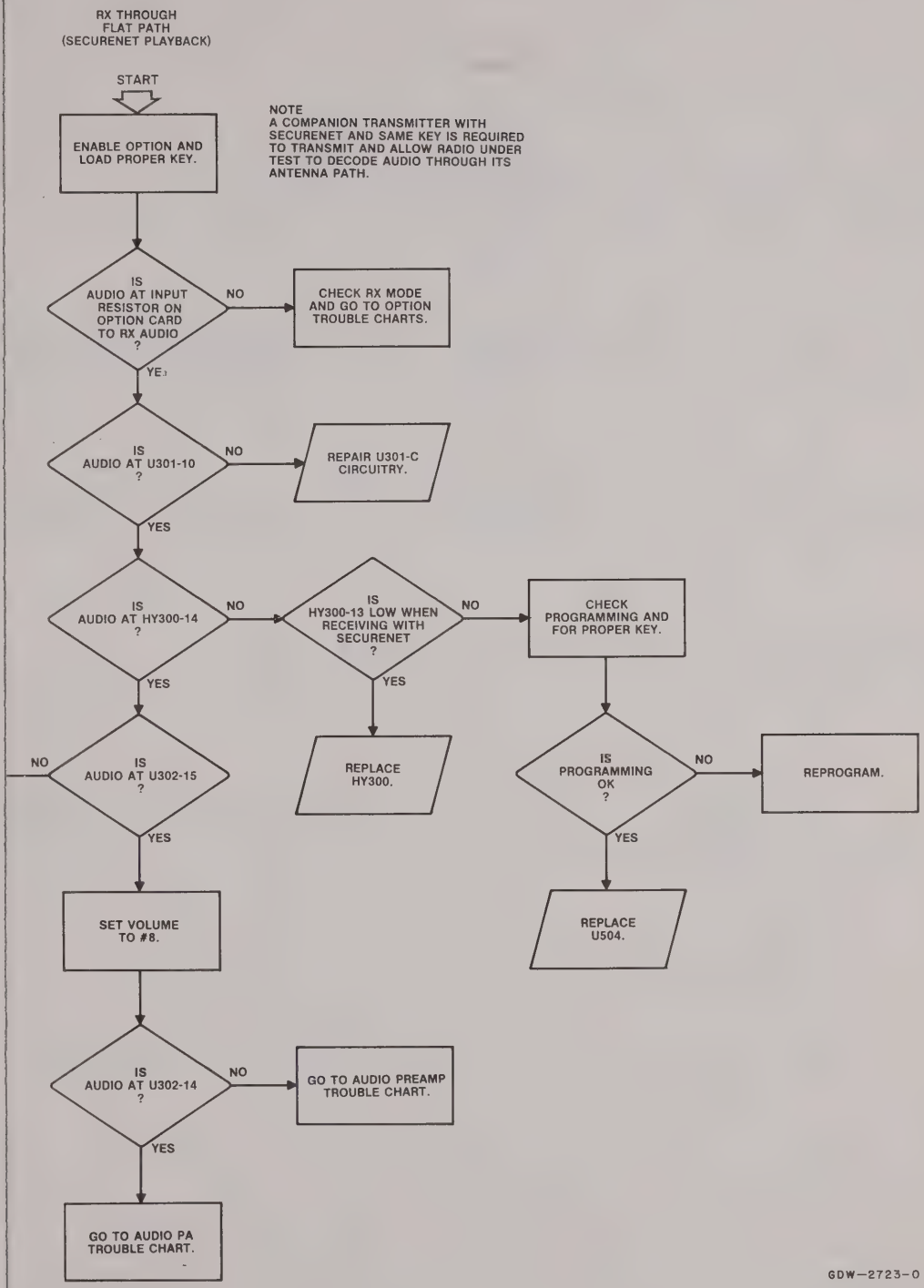
NOTE: THE SIGNALS TO BE DETECTED ARE SHORT DATA BURSTS WHEN THE RADIO POWERS UP OR WHEN THE SYSTEM IS RESET. THE SIGNALS STOP AFTER SUCCESSFUL NODE TO NODE TRANSMISSION (RADIO TO CONTROL UNIT, THEN CONTROL UNIT TO RADIO). THESE SIGNALS ARE EASIEST TO DETECT BY SWITCHING THE SYSTEM ON AND OFF AT THE CONTROL UNIT WHILE OBSERVING THE DATA AND BUSY SIGNALS.

GEW-2710-D



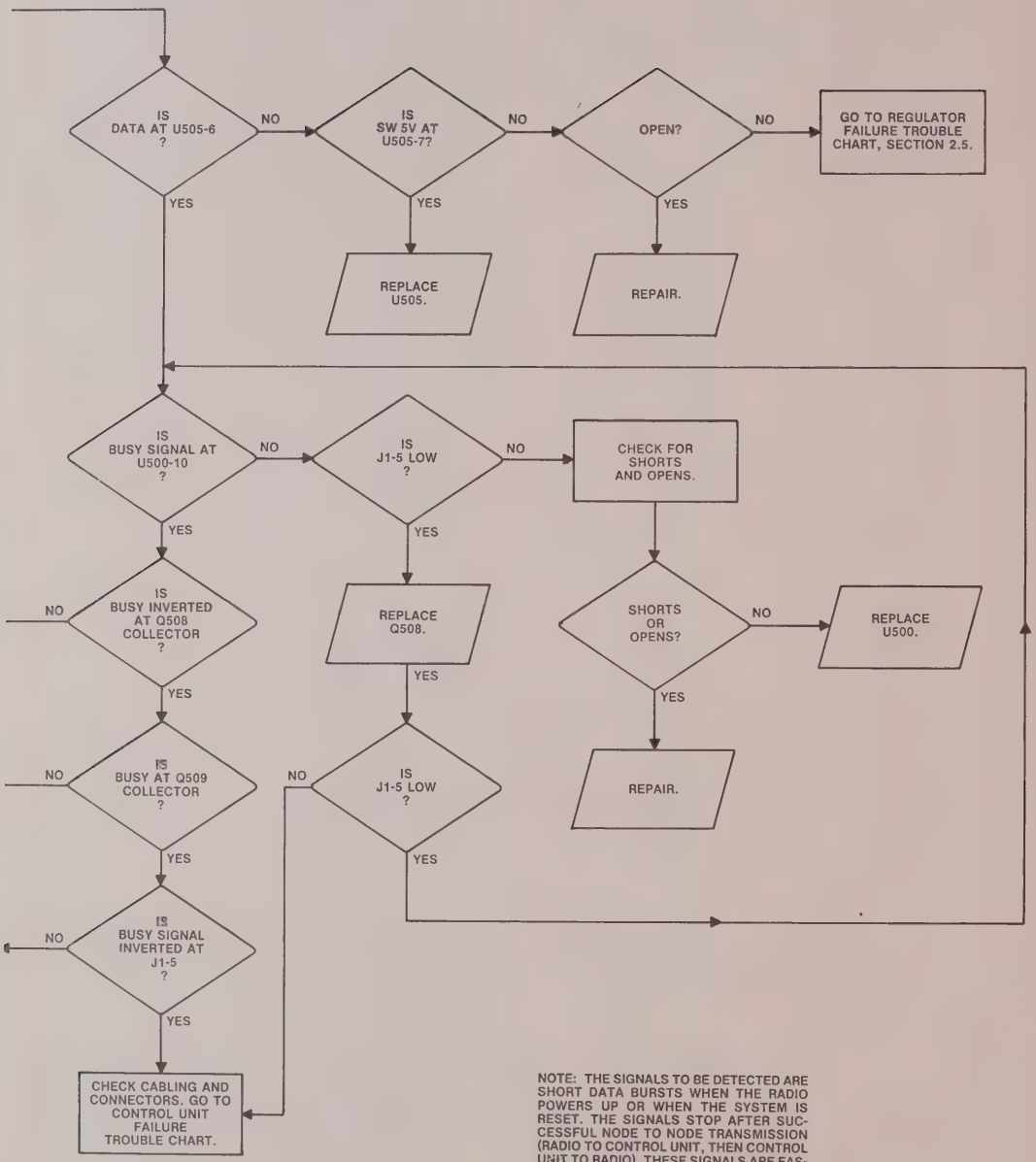
NOTE: THE SIGNALS TO BE DETECTED ARE SHORT DATA BURSTS WHEN THE RADIO POWERS UP OR WHEN THE SYSTEM IS RESET. THE SIGNALS STOP AFTER SUCCESSFUL NODE TO NODE TRANSMISSION (RADIO TO CONTROL UNIT, THEN CONTROL UNIT TO RADIO). THESE SIGNALS ARE EASIEST TO DETECT BY SWITCHING THE SYSTEM ON AND OFF AT THE CONTROL UNIT WHILE OBSERVING THE DATA AND BUSY SIGNALS.

GEW-2710-0



GDW—2723-0

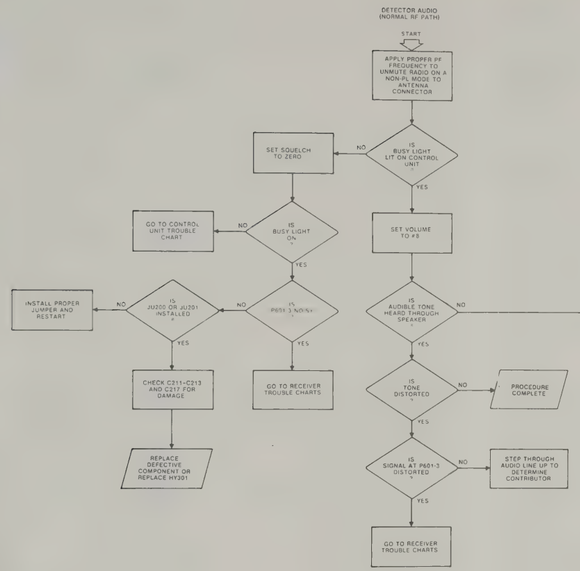
Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 3 of 4)
5/10/88

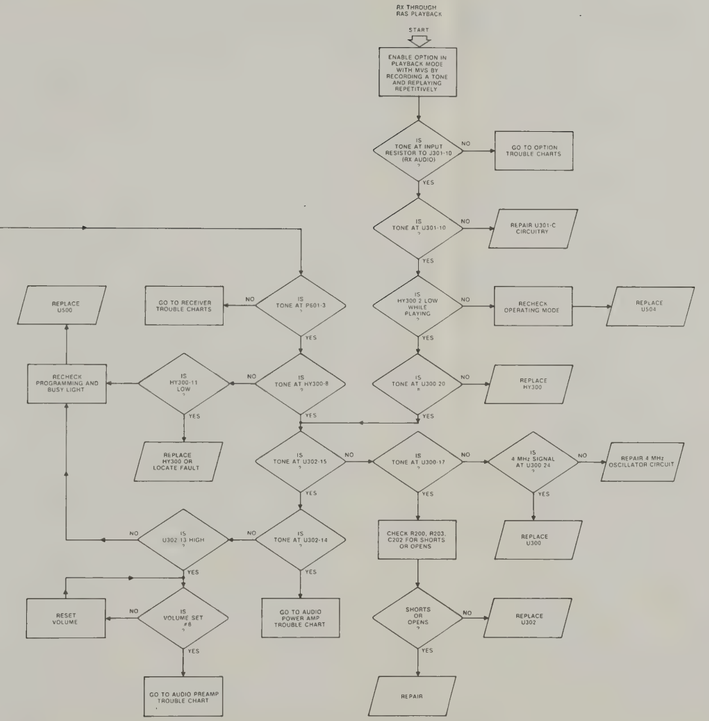


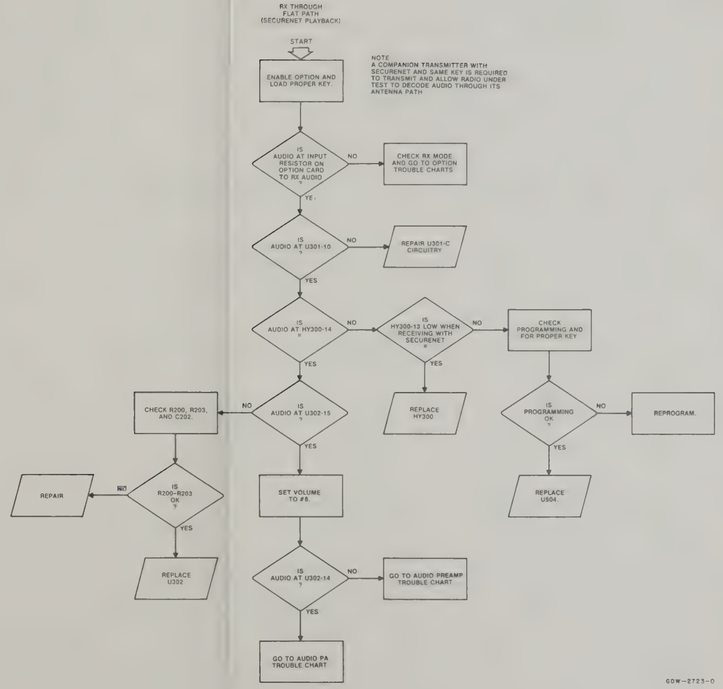
NOTE: THE SIGNALS TO BE DETECTED ARE SHORT DATA BURSTS WHEN THE RADIO POWERS UP OR WHEN THE SYSTEM IS RESET. THE SIGNALS STOP AFTER SUCCESSFUL NODE TO NODE TRANSMISSION (RADIO TO CONTROL UNIT, THEN CONTROL UNIT TO RADIO). THESE SIGNALS ARE EASIEST TO DETECT BY SWITCHING THE SYSTEM ON AND OFF AT THE CONTROL UNIT WHILE OBSERVING THE DATA AND BUSY SIGNALS.

GEW-2710-0

RX ROUTING

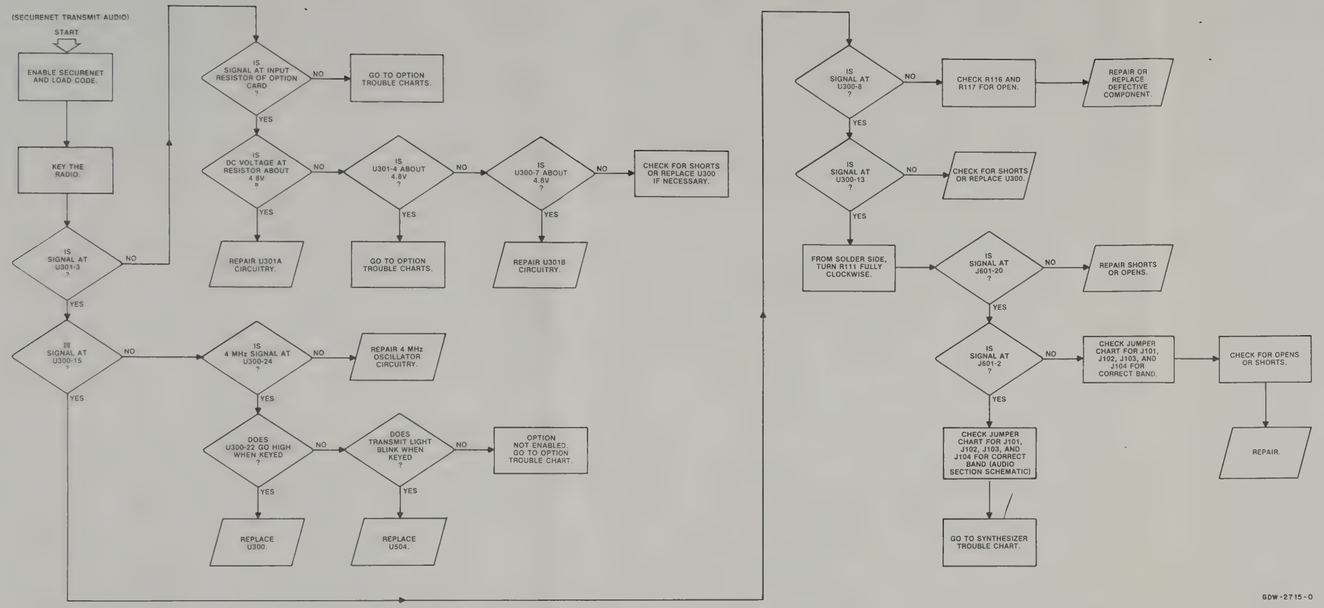


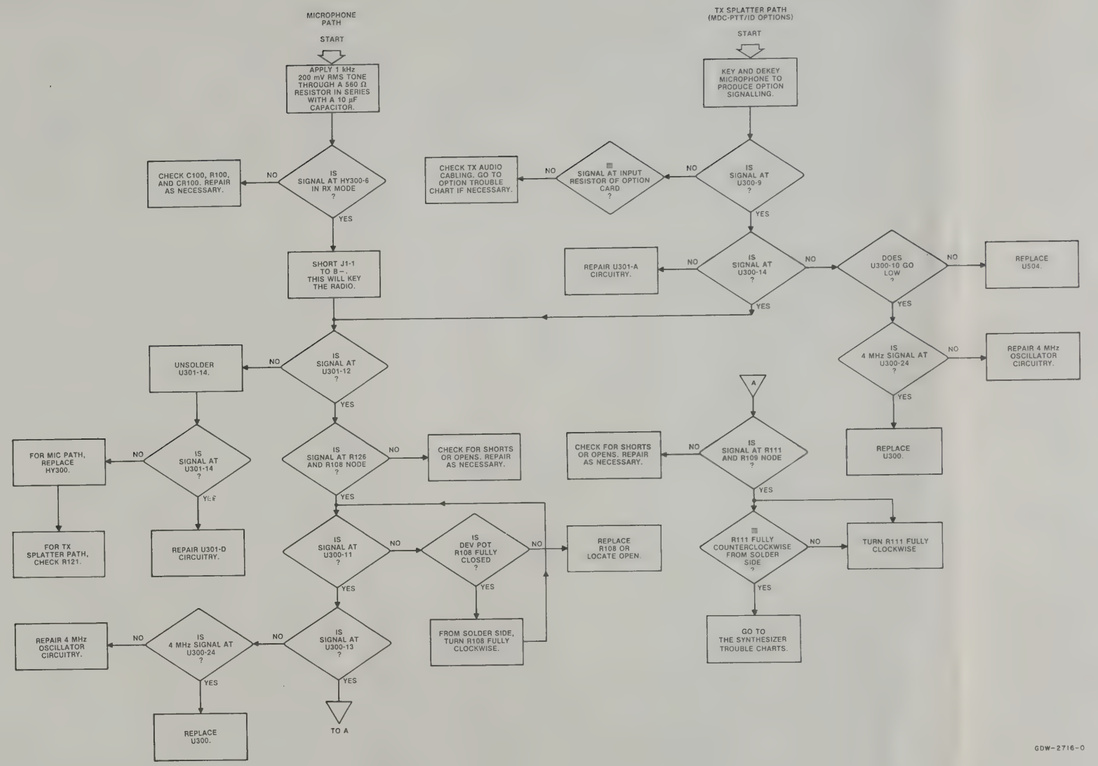




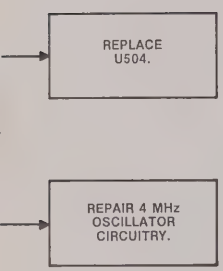
Troubleshooting Charts for
HLN5299B Personality Board
PW-4551-A
(Sheet 3 of 4)
5/10/88

TX ROUTING





Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 4 of 4)
5/10/88


REPLACE
U504.
REPAIR 4 MHz
OSCILLATOR
CIRCUITRY.

ION GATE HYBRID

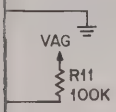
parts list

Transmission Gate (p/o HLN5299B Personality Board) MXW–4562–A

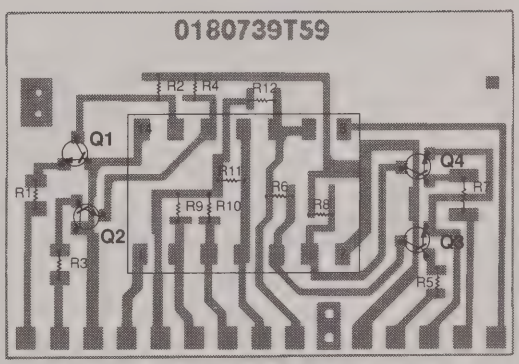
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY300	01–80739T59	includes the following
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R7	06–11077B17	56k
transistor (see note)		
Q1–4	48–80141L02	NPN
integrated circuit (see note)		
U1	51–80073C05	analog t–gate

5/4/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



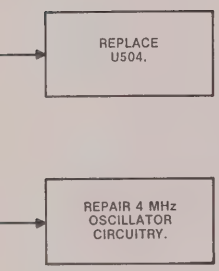
NOTE:
U1 = 5180073C05
PIN 14 = VDD (9.6V)
PIN 7 = VSS (GND)



SUBSTRATE ● GPW–4354–A
OVERLAY — GPW–4355–A

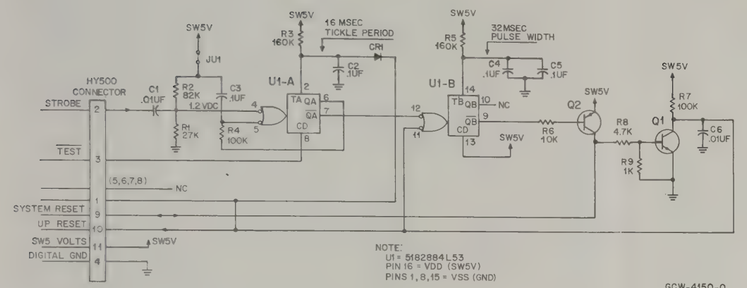
GCW-4148-O

Schematics, Circuit Board Diagrams, and Parts Lists for the Transmission Gate, Squelch, and Watchdog Timer Hybrids
PW–4561–D
6/30/89


REPLACE
U504.

REPAIR 4 MHz
OSCILLATOR
CIRCUITRY.

WATCHDOG TIMER



NOTE:
U1 = 5182884L53
PIN 16 = VDD (SW5V)
PINS 1, 8, 15 = VSS (GND)

GCW-4150-O

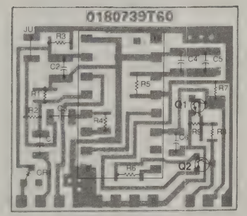
parts list

Watchdog Timer (p/o HLN5299B Personality Board) MXW-4564-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY500	01-80739T60	includes the following
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21-13741B45	.01, ±10%
C2	21-13741C17	.1, ±20%, 25V
C3	21-11032B13	1, +80, -20%, electrolytic
C4,5	21-13741C17	.1, ±20%, 25V
C6	21-13741B45	.01, ±10%
diode (see note)		
CR1	48-80236E08	silicon
jumper		
JU1	06-11024B23	0 ohm
transistor (see note)		
Q1	48-80141L04	NPN
Q2	48-80141L03	PNP
integrated circuit (see note)		
U1	51-82884L53	monostable multivibrator

1/03/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



SUBSTRATE ● GPW-4358-A
OVERLAY — GPW-4359-A

SQUELCH HYBRID

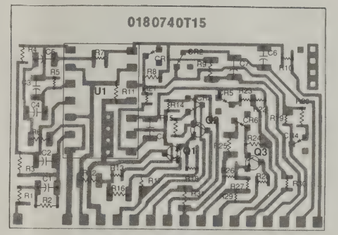
parts list

Squelch Hybrid (p/o HLN5299B Personality Board) MXW-4563-C

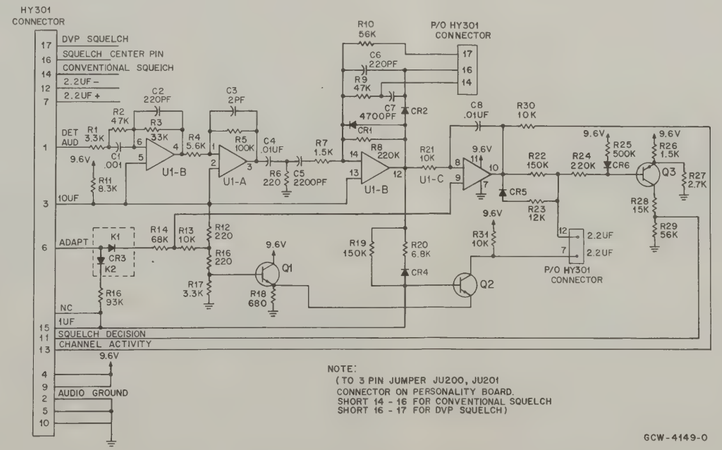
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY301	01-80740T15	includes the following
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21-13740B73	.001
C2	21-13740B57	220 pF
C3	21-13740B47	82 pF
C4	21-13741N45	.01
C5	21-13741N29	.0022
C6	21-13740B57	220 pF
C7	21-13741N37	.0047, ±10%
C8	21-13741N45	.01
diode (see note)		
CR1-6	48-80236E08	silicon
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6	06-11077A58	220
R9	06-11077B17	47k
R12	06-11077A58	220
R16	06-11077A58	220
R25	06-11077B45	820k
R31	06-11077A98	10k
transistor (see note)		
Q1,2	48-30141L04	NPN
Q3	48-80141L01	PNP
integrated circuit (see note)		
U1	51-80067C06	quad opamp

1/03/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



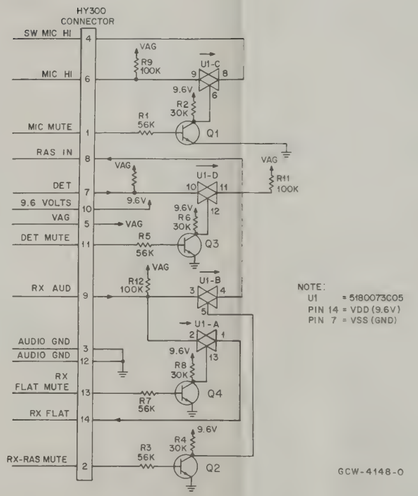
SUBSTRATE ● GPW-4356-A
OVERLAY — GPW-4357-A



NOTE:
(TO 3 PIN JUMPER JU200, JU201
CONNECTOR ON PERSONALITY BOARD.
SHORT 14 - 16 FOR CONVENTIONAL SQUELCH
SHORT 16 - 17 FOR DVP SQUELCH)

GCW-4149-O

TRANSMISSION GATE HYBRID



NOTE:
U1 = 5180073C05
PIN 14 = VDD (9.6V)
PIN 7 = VSS (GND)

GCW-4148-O

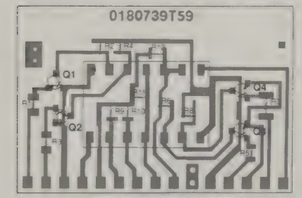
parts list

Transmission Gate (p/o HLN5299B Personality Board) MXW-4562-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY300	01-80739T59	includes the following
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R7	06-11077B17	56k
transistor (see note)		
Q1-4	48-80141L02	NPN
integrated circuit (see note)		
U1	51-80073C05	analog I-gate

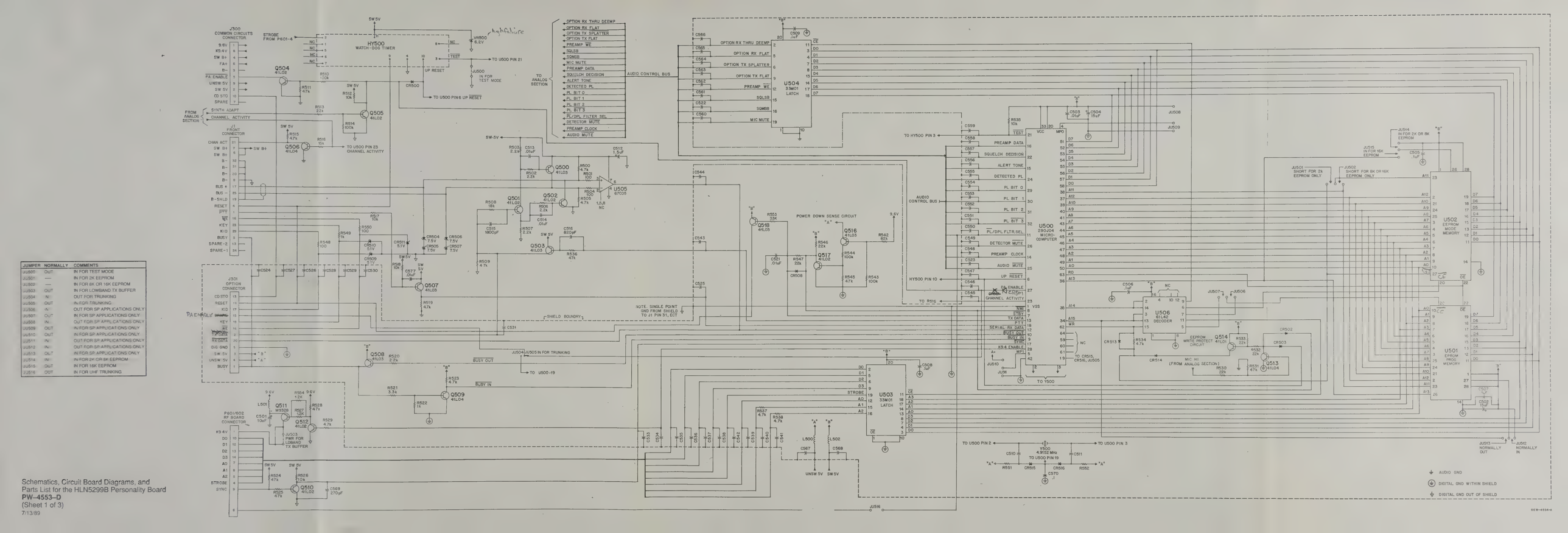
5-4 88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



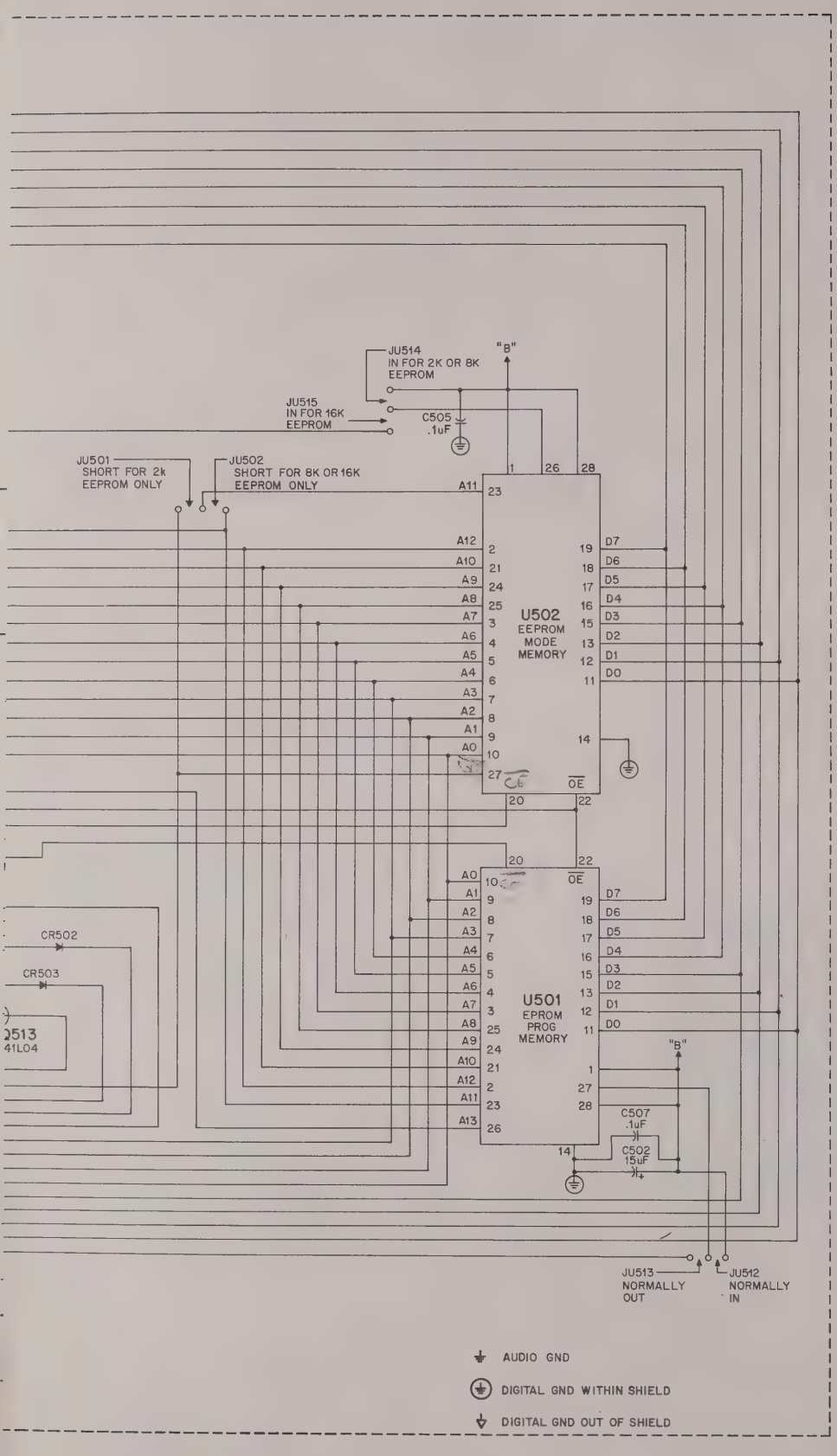
SUBSTRATE ● GPW-4354-A
OVERLAY — GPW-4355-A

Schematics, Circuit Board Diagrams, and Parts Lists for the Transmission Gate, Squelch, and Watchdog Timer Hybrids
PW-4561-D
6/30/89

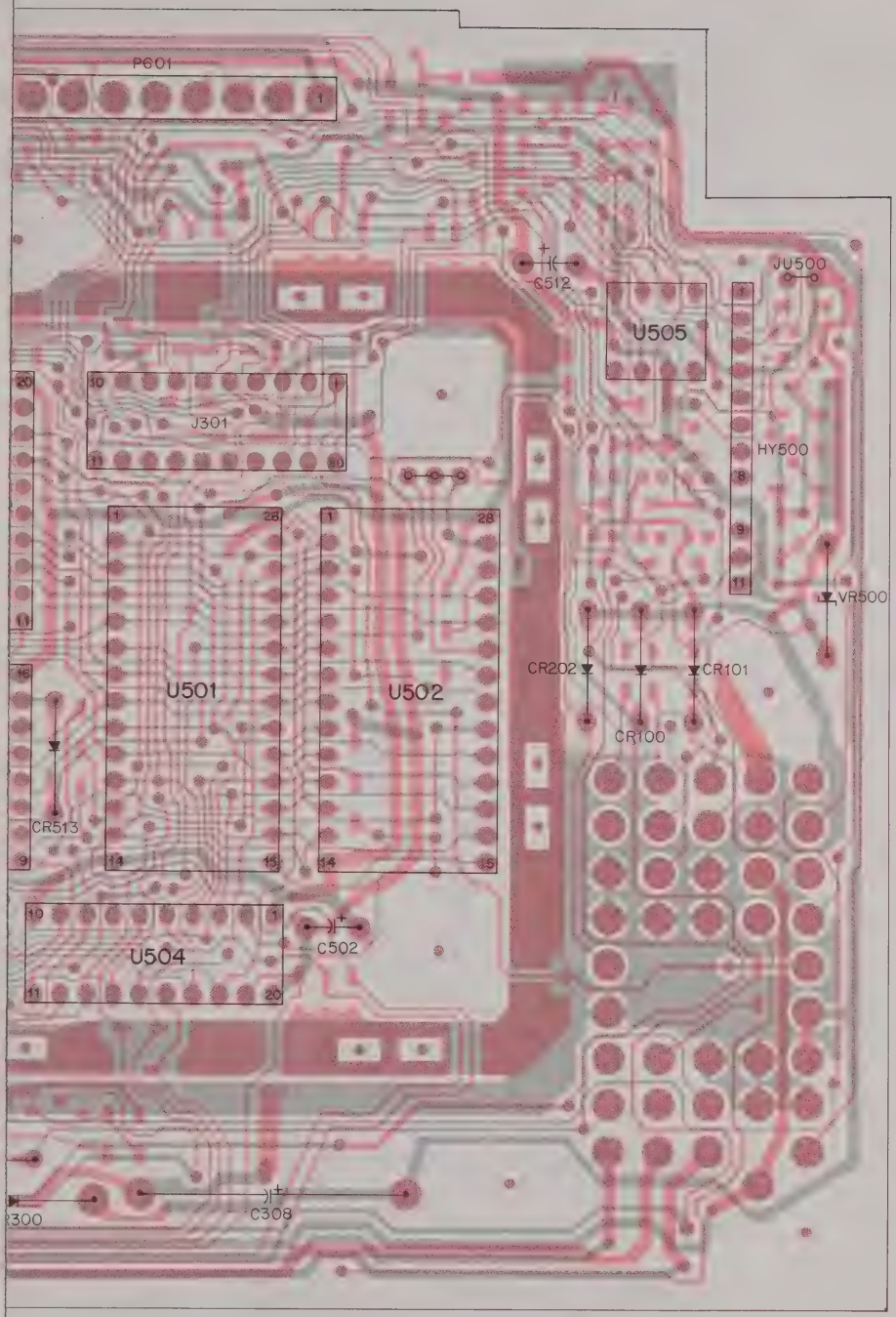


JUMPER	NORMALLY	COMMENTS
JU500	OUT	IN FOR TEST MODE
JU501	—	IN FOR 2K EEPROM
JU502	—	IN FOR 8K OR 16K EEPROM
JU503	OUT	IN FOR LOWBAND TX BUFFER
JU504	IN	OUT FOR TRUNKING
JU505	OUT	IN FOR TRUNKING
JU506	IN	OUT FOR SP APPLICATIONS ONLY
JU507	OUT	IN FOR SP APPLICATIONS ONLY
JU508	IN	OUT FOR SP APPLICATIONS ONLY
JU509	OUT	IN FOR SP APPLICATIONS ONLY
JU510	OUT	IN FOR SP APPLICATIONS ONLY
JU511	IN	OUT FOR SP APPLICATIONS ONLY
JU512	IN	OUT FOR SP APPLICATIONS ONLY
JU513	OUT	IN FOR SP APPLICATIONS ONLY
JU514	IN	IN FOR 2K OR 8K EEPROM
JU515	OUT	IN FOR 16K EEPROM
JU516	OUT	IN FOR UHF TRUNKING

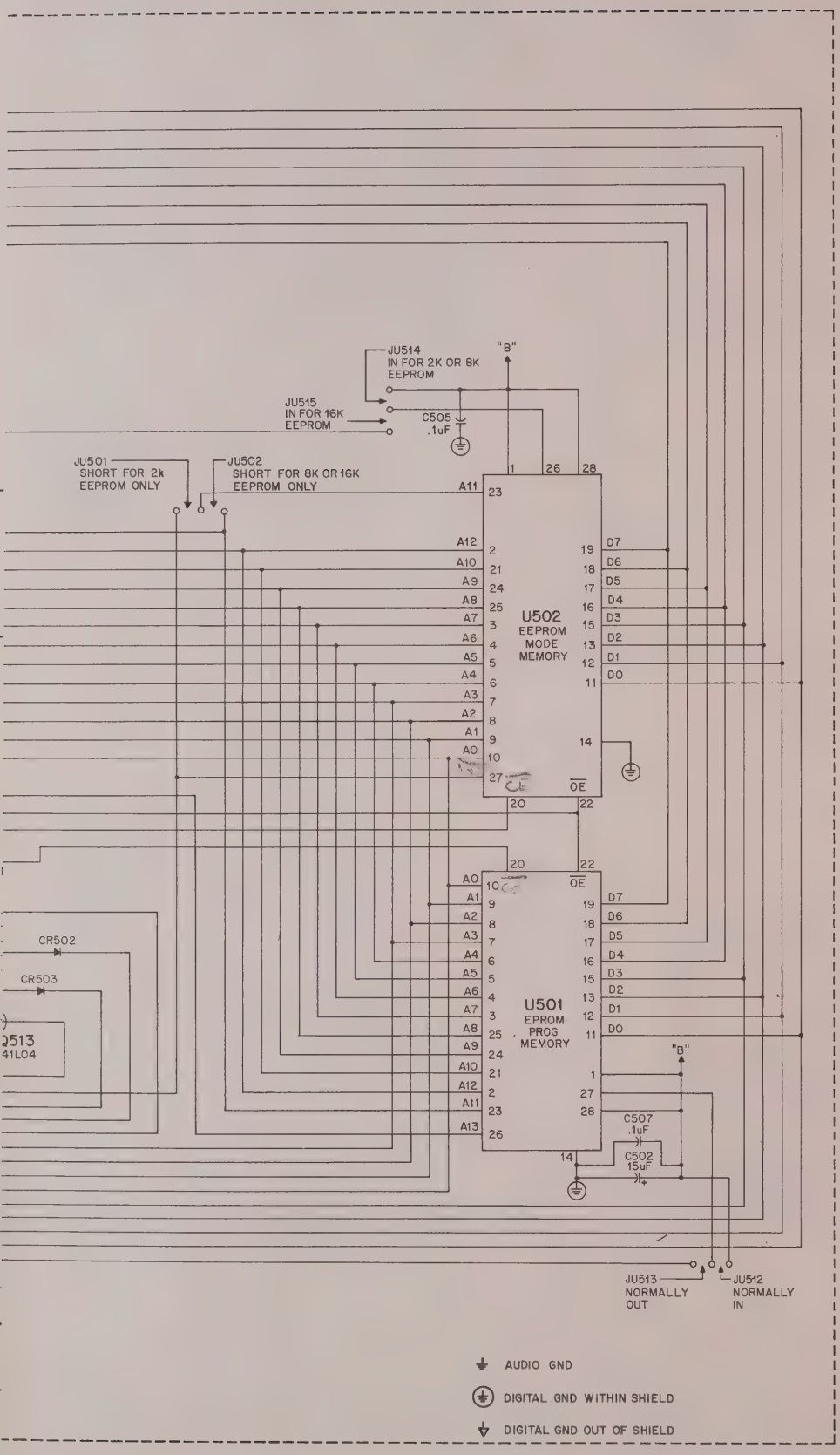
Schematics, Circuit Board Diagrams, and Parts List for the HLN5299B Personality Board
PW–4553–D
(Sheet 1 of 3)
7/13/89


JU514
IN FOR 2K OR 8K
EEPROM
"B"
JU515
IN FOR 16K
EEPROM
C505
.1uF
JU501
SHORT FOR 2k
EEPROM ONLY
JU502
SHORT FOR 8K OR16K
EEPROM ONLY
U502
EEPROM
MODE
MEMORY
U501
EPROM
PROG
MEMORY
CR502
CR503
C507
.1uF
C502
15uF
JU513
NORMALLY
OUT
JU512
NORMALLY
IN
AUDIO GND
DIGITAL GND WITHIN SHIELD
DIGITAL GND OUT OF SHIELD

GEW-4554-A

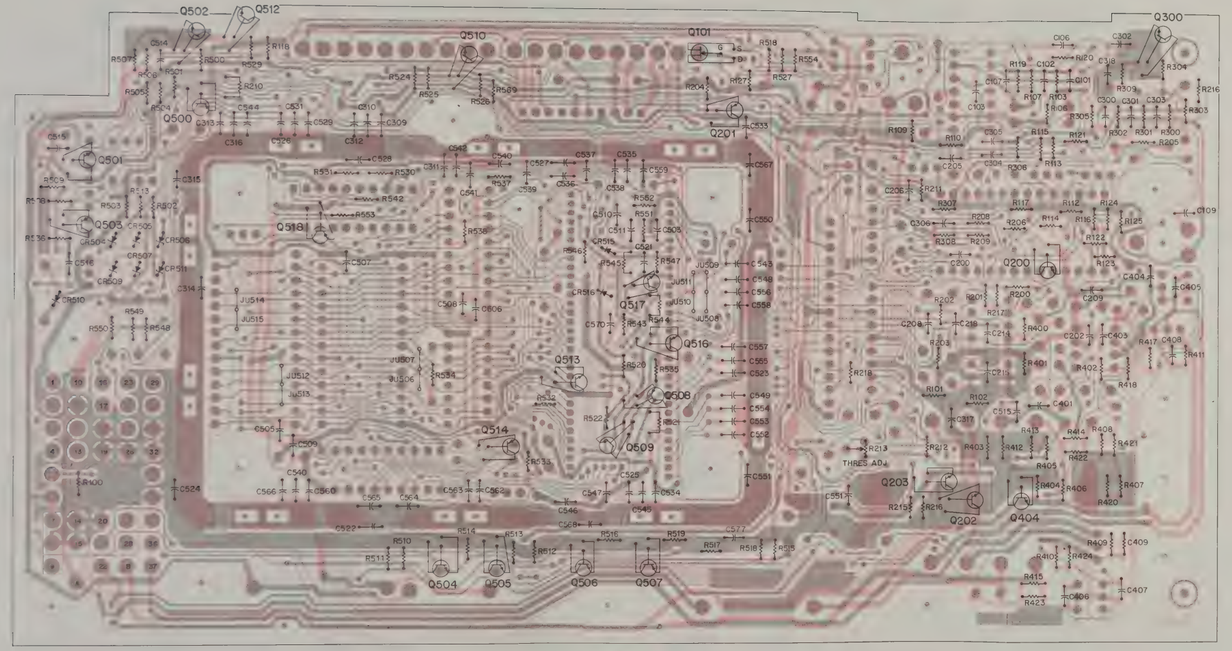


Schematics, Circuit Board Diagrams, and
Parts List for the HLN5299B Personality Board
PW–4553–D
(Sheet 2 of 3)
7/13/89


JU514
IN FOR 2K OR 8K
EEPROM
"B"
JU515
IN FOR 16K
EEPROM
C505
.1uF
JU501
SHORT FOR 2k
EEPROM ONLY
JU502
SHORT FOR 8K OR16K
EEPROM ONLY
U502
EEPROM
MODE
MEMORY
U501
EPROM
PROG
MEMORY
C507
.1uF
C502
15uF
CR502
CR503
JU513
NORMALLY
OUT
JU512
NORMALLY
IN
AUDIO GND
DIGITAL GND WITHIN SHIELD
DIGITAL GND OUT OF SHIELD

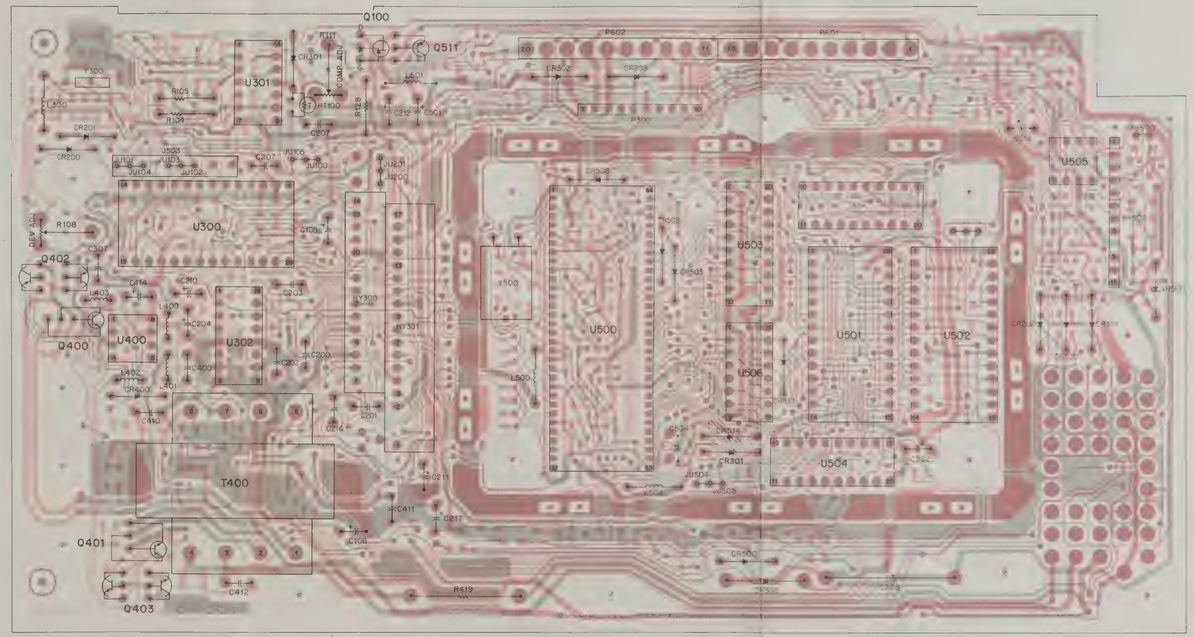
GEW-4554-A

HLN5299B PERSONALITY BOARD



SHOWN FROM SOLDER SIDE

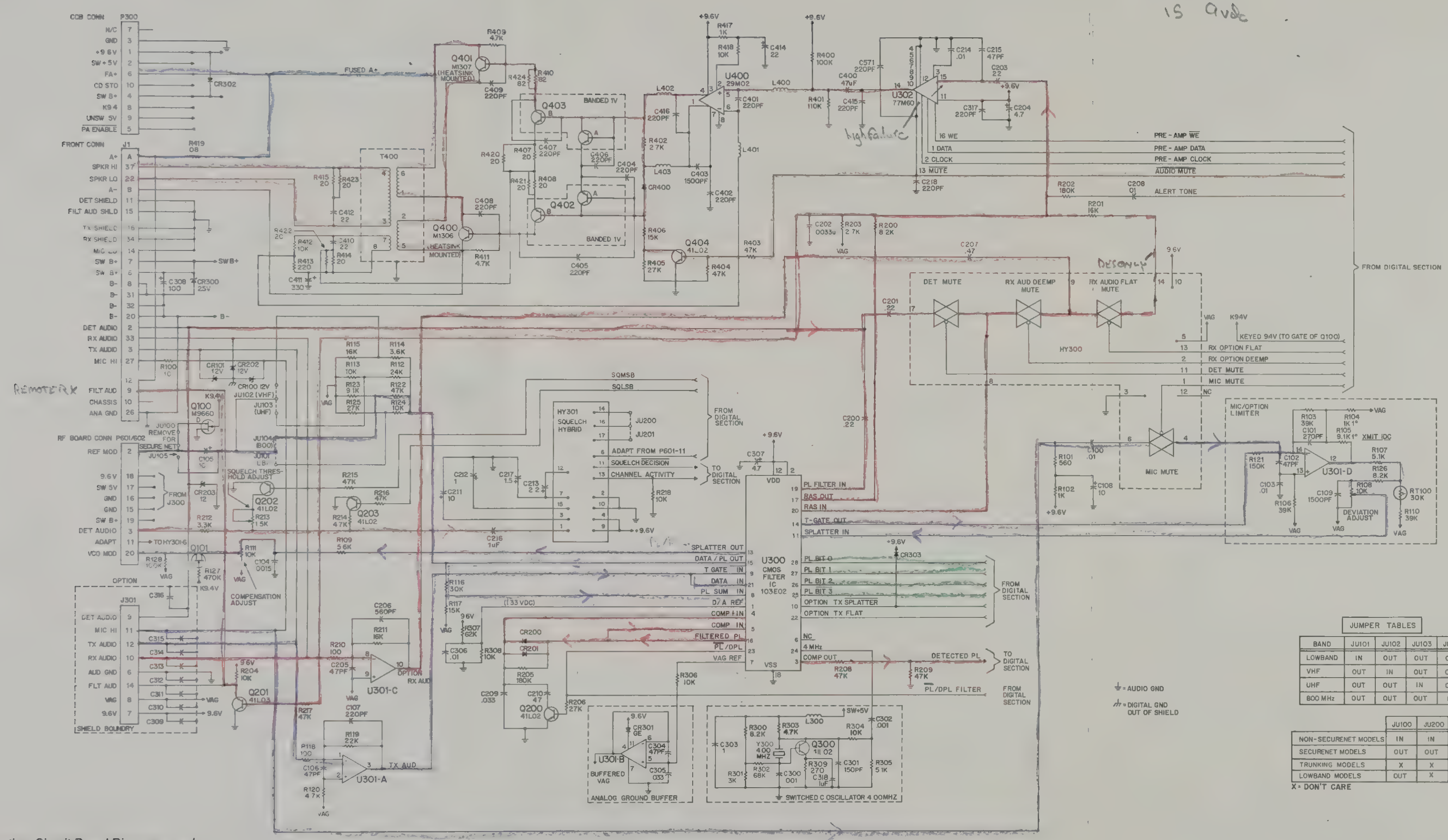
SOLDER SIDE ○ GEW-4555-B
COMPONENT SIDE ● GEW-4556-B
OVERLAY — GEW-4557-A



SHOWN FROM COMPONENT SIDE

SOLDER SIDE ● GEW-4555-B
COMPONENT SIDE ● GEW-4556-B
OVERLAY — GEW-4558-0

Schematics, Circuit Board Diagrams, and
Parts List for the HLN5299B Personality Board
PW-4553-D
(Sheet 2 of 3)
7/13/89



JUMPER TABLES

BAND	JU101	JU102	JU103	JU104	JU105
LOWBAND	IN	OUT	OUT	OUT	IN
VHF	OUT	IN	OUT	OUT	OUT
UHF	OUT	OUT	IN	OUT	OUT
800 MHz	OUT	OUT	OUT	IN	OUT

	JU100	JU200	JU201	JU505
NON-SECURENET MODELS	IN	IN	OUT	X
SECURENET MODELS	OUT	OUT	IN	X
TRUNKING MODELS	X	X	X	IN
LOWBAND MODELS	OUT	X	X	X

X = DON'T CARE

GEW-4560-B

Schematics, Circuit Board Diagrams, and Parts List for the HLN5299B Personality Board
PW–4553–D
(Sheet 3 of 3)
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parts list

HLN5299B Personality Board — MXW–4559–E

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C100	08–11051A07	.01, 63V
C101	21–13740B59	270 pF
C102	21–13740B41	47 pF
C103	21–13741N45	.01, ±10%
C104	08–11051A02	.0015, 63V
C105	23–11048C11	10, ±20%, 35V, electrolytic
C106	21–13740B41	47 pF
C107	21–13740B57	220 pF
C108	23–11048C11	10, ±20%, 35V, electrolytic
C109	21–13740B76	1500 pF, ±5 pF
C200	21–11032B15	.22, +80, –20% 50V
C201	08–11051A15	.22, 63V
C202	08–11051A04	.0033, 63V
C203	08–11051A15	.22, 63V
C204	23–11013D55	4.7, ±20%, 20V, tantalum
C204	23–11054N08	4.7, ±10%, 35V, tantalum
C205	21–13740B41	47 pF
C206	21–13740B67	560 pF
C207	08–11051A17	.47, 63V
C208	21–13741N45	.01, ±10%
C209	21–13741N57	033 uF, ±10%
C210	08–11051A17	.47, 63V
C211	23–11048C11	10, ±20%, 35V, electrolytic
C212	23–11048C05	1, ±20%, electrolytic
C213	23–11048C06	2.2, ±20%, electrolytic
C214	21–13741N45	.01, ±10%
C215	21–13740B41	47 pF
C216	08–11051A13	.1, 63V
C217	23–11054N02	1.5, ±10%, 35V, tantalum
C218	21–13740B57	220 pF
C300	21–13741N21	.001, ±10%
C301	21–13740B53	150 pF
C302	21–13741N21	.001, ±10%
C303	21–11032B13	.10, +80, –20% 50V
C304	21–13740B41	47 pF
C305	21–11032B15	.22, +80, –20% 50V
C306	21–13741N45	.01, ±10%
C307	23–84538G06	47, ±20%, 20V, tantalum
C308	23–84669A08	100, –10, +150%, 25V, electrolytic
C309–316	21–13740B49	12 pF
C317	21–13740B57	220 pF
C400	08–11051A17	.47, 63V
C401,402	21–13740B57	220 pF
C403	21–13740B76	.0015 uF, ±5 pF
C404,409	21–13740B57	220 pF
C410	08–11051A15	.22, 63V
C411	23–82747L01	330, –10, +100%, 20V, electrolytic
C412	08–11051A15	.22, 63V
C414	23–11054F10	22, ±10%, 15V, tantalum
C415,416	21–13740B57	220 pF
C501	23–11048C11	10, ±20%, 35V, electrolytic
C502	23–11054H10	15, ±10%, 25V, tantalum
C503	21–13741N45	.01, ±10%
C504	23–11054H10	15, ±10%, 25V, tantalum
C505–509	21–11032B13	.1, +80, –20% 50V
C510,511	21–13740B25	12 pF
C512	23–11054N02	1.5, ±10%, 35V, tantalum
C513,514	21–13741N45	.01, ±10%
C515	21–13740B78	.0018 uF
C516	21–11031G61	820 pF
C521	21–11032B13	.1, +80, –20% 50V
C522–569	21–13741N07	270 pF, ±10%
C570	21–13741N45	.1, +80, –20%
C571–576	21–13740B57	220 pF
C577	21–13741N45	.01, ±10%
diode (see note)		
CR100,101	48–80007E02	12V zener
CR200,201	48–83654H01	silicon
CR202,203	48–80007E02	12V zener
CR300	48–80236E07	28V zener
CR301	48–82178A01	germanium
CR302	48–80008E01	rectifier silicon
CR303	48–82178A01	germanium
CR400	48–83654H01	silicon
CR500–503	48–83654H01	silicon
CR504–507	48–80140L11	5V zener
CR508	48–83654H01	silicon
CR509–511	48–80140L06	1V zener
CR513,514	48–83654H01	silicon
CR515,516	48–80013E02	silicon pin
hybrid (see note)		
HY300	01–80739T59	transmission gate, see parts list MXW–4562
HY301	01–80740T15	squelch, see parts list MXW–4563
HY500	01–80739T60	watchdog timer, see parts list MXW–4564
connector receptacle		
J1	01–80746T79	front connector assembly
J100,101	28–84318M07	3 pin
J103	28–84318M07	3 pin
J200	28–84318M07	3 pin
J301	09–80269B05	dual socket
J500	28–84318M06	2 pin
J501	28–84318M07	3 pin
J504	28–84318M07	3 pin
J516	28–84318M06	2 pin
jumper		
JU100,101	09–80080L01	0 ohm
JU200	09–80080L01	0 ohm

MXW–4559–E (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
JU501	09–80080L01	0 ohm
JU504	09–80080L01	0 ohm
JU506	06–11077A01	0 ohm resistor
JU508	06–11077A01	0 ohm resistor
JU511,512	06–11077A01	0 ohm resistor
JU514	06–11077A01	0 ohm resistor
coil, RF		
L300	24–80293D02	ferrite
L400–403	24–80036A01	ferrite, 1/2 turn
L500	24–80138G04	5.6 uH, ±5%
L501	24–80036A01	ferrite, 1/2 turn
L502	24–80138G04	5.6 uH, ±5%
connector plug		
P300	28–80264K01	top entry
P601,602	28–82647K02	10 pin
transistor (see note)		
Q100	48–00869660	P–Channel, JFET
Q101	48–05128M66	N–Channel, JFET
Q200	48–80141L02	NPN
Q201	48–80141L03	PNP
Q202,203	48–80141L02	NPN
Q300	48–80141L02	NPN
Q402	01–80734T95	PNP transistor & clip assembly
Q403	01–80734T96	NPN transistor & clip assembly
Q404	48–80141L02	NPN
Q448	48–84413L07	PNP
Q449	48–84413L06	NPN
Q500	48–80141L03	PNP
Q501,502	48–80141L04	NPN
Q503	48–80141L03	PNP
Q504,505	48–80141L02	NPN
Q506	48–80141L04	NPN
Q507,508	48–80141L03	PNP
Q509	48–80141L04	NPN
Q510	48–80141L02	NPN
Q511	48–00869328	PNP
Q512,513	48–80141L04	NPN
Q514	48–80141L01	PNP
Q516	48–80141L03	PNP
Q517	48–80141L02	NPN
Q518	48–80141L03	PNP
thermistor		
RT100	06–80176D03	thermistor
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R100	06–11077A26	10
R101	06–11077A68	560
R102	06–11077A74	1k
R103	06–11077B13	39k
R104	06–11049B94	1k, ±1%, 1/4W
R105	06–11049C87	9090, ±1%, 1/4W
R106	06–11077B13	39k
R107	06–11077A92	5.6k
R108	18–80087E08	10k potentiometer
R109	06–11077A92	5.6k
R110	06–11077B13	39k
R111	18–80087E08	10k potentiometer
R112	06–11077B08	24k
R113	06–11077A98	10k
R114	06–11077A87	3.6k
R115	06–11077B04	16k
R116	06–11077B10	30k
R117	06–11077B03	15k
R118	06–11077A50	100
R119	06–11077B07	22k
R120	06–11077A90	4 7k
R121	06–11077B27	150k
R122	06–11077B15	47k
R123	06–11077A97	9.1k
R124	06–11077A98	10k
R125	06–11077B09	27k
R126	06–11077A96	8.2k
R127	06–11077B29	180k
R128	06–11009A97	100k
R200	06–11077A96	8.2k
R201	06–11077B04	16k
R202	06–11077B29	180k
R203	06–11077A84	2.7k
R204	06–11077A98	10k
R205	06–11077B29	180k
R206	06–11077B09	27k
R208,209	06–11077B15	47k
R210	06–11077A50	100
R211	06–11077B04	16k
R212	06–11077A86	3.3k
R213	18–05500L17	1.5k, ±20%, 100V, potentiometer
R214	06–11077A90	4.7k
R215–217	06–11077B15	47k
R218	06–11077A98	10k
R300	06–11077A96	8.2k
R301	06–11077A85	3k
R302	06–11077B19	68k
R303	06–11077A90	4.7k
R304	06–11077A98	10k
R305	06–11077A91	5.1k
R306	06–11077A98	10k
R307	06–11077B18	62k
R308	06–11077A98	10k
R309	06–11077A60	270

MXW–4559–E (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R400	06–11077B23	100k
R401	06–11077B24	110k
R402	06–11077A84	2.7k
R403,404	06–11077B15	47k
R405	06–11077B09	27k
R406	06–11077B03	15k
R407,408	06–11077A33	20
R409	06–11077A90	4.7k
R410	06–11077A48	82
R411	06–11077A90	4.7k
R412	06–11077A98	10k
R413	06–11077A58	220
R414,415	06–11077A33	20
R417	06–11077A74	1k
R418	06–11077A98	10k
R419	17–82350A14	.08, ±20%, 1W
R420,423	06–11077A33	20
R424	06–11077A48	82
R500	06–11077A90	4.7k
R501	06–11077A50	100
R502,503	06–11077A82	2.2k
R504	06–11077A50	100
R505	06–11077A90	4 7k
R506,507	06–11077A82	2.2k
R508	06–11077B05	18k
R509	06–11077A90	4.7k
R510	06–11077B23	100k
R511	06–11077B15	47k
R512	06–11077A98	10k
R513	06–11077B07	22k
R514	06–11077B23	100k
R515	06–11077A90	4.7k
R516	06–11077B03	15k
R517,518	06–11077A98	10k
R519	06–11077A90	4.7k
R520	06–11077A82	2.2k
R521	06–11077A86	3.3k
R522	06–11077A74	1k
R523	06–11077A90	4.7k
R524,525	06–11077B15	47k
R526	06–11077A98	10k
R527	06–11077A76	1.2k
R528	06–11077B15	47k
R529	06–11077A90	4.7k
R530	06–11077B07	22k
R531	06–11077B15	47k
R532,533	06–11077B07	22k
R534	06–11077A90	4.7k
R535	06–11077A98	10k
R536	06–11077B15	47k
R537,538	06–11077A90	4.7k
R542	06–11077B21	82k
R543,544	06–11077B23	100k
R545	06–11077B15	47k
R546	06–11077B07	22k
R547	06–11077A90	4.7k
R548	06–11077A50	100
R549	06–11077A74	1k
R550	06–11077A50	100
R551,552	06–11077A98	10k
R553	06–11077B07	22k
R554	06–11077A76	1.2k
transformer		
T400	25–84083B03	audio
integrated circuit (see note)		
U300	51–80103E02	switch filter
U301	51–80067C04	opamp
U301	51–80067C06	opamp
U302	51–83977M60	digital volume control
U400	51–84621K14	driver
U500	51–80290J04	1.5 MHz microprocessor
U501	——	radio software (see model chart)
U502	——	EEPROM software (see model chart)
U503	51–05133M01	octal latch
U504	51–05133M01	octal latch
U505	51–80067C05	opamp
U506	51–84561L42	bipolar
voltage regulator (see note)		
VR500	48–83696E07	6.2V zener
crystal (see note)		
Y300	48–80173D01	4 MHz
Y500	48–80173D12	4.9152 MHz
mechanical parts		
	03–10943M10	tapping screw (3 x 0.5 x 8)
	03–10911A11	machine screw (3 x 0.5 x 8)
	04–84180C01	nylon shoulder washer
	07–05375P09	plated lead
	07–80042L01	hybrid support
	09–80269B03	dual socket
	09–82808R10	28 contact
	09–80269B01	dual socket
	09–82808R04	16 contact
	09–80002K01	socket
	14–80175M01	insulator shield
	14–80175M03	insulator shield
	14–80179N01	crystal pad

MXW–4559–E (4)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	14–80206M01	heat sink insulator
	14–83820M02	heat conductive insulator
	26–80033M01	RFI shield
	26–80051K01	solder side option shield
	26–83498M01	heat sink
	28–80264K01	top entry
	28–82647K02	10 pin
	28–83485M05	male plug assembly
	29–10134A68	lug connector
	29–10134A70	lug connector
	32–80219B01	housing gasket
	37–00132026	tubing
	37–00132026	3/16 clear heatshrink tubing
	37–00132526	1/16 heatshrink tubing
	42–82891K01	transistor clip, 2 used
	43–80054K02	support spacer
	54–80072G01	circuit board label
	55–84300B04	handle
	75–80051P01	crystal pad
	75–80129N01	crystal mounting pad
	75–80144H01	vibration pads

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R400	06–11077B23	100k
R401	06–11077B24	110k
R402	06–11077A84	2.7k
R403,404	06–11077B15	47k
R405	06–11077B09	27k
R406	06–11077B03	15k
R407,408	06–11077A33	20
R409	06–11077A90	4.7k
R410	06–11077A48	82
R411	06–11077A90	4.7k
R412	06–11077A98	10k
R413	06–11077A58	220
R414,415	06–11077A33	20
R417	06–11077A74	1k
R418	06–11077A98	10k
R419	17–82350A14	.08, ±20%, 1W
R420,423	06–11077A33	20
R424	06–11077A48	82
R500	06–11077A90	4.7k
R501	06–11077A50	100
R502,503	06–11077A82	2.2k
R504	06–11077A50	100
R505	06–11077A90	4.7k
R506,507	06–11077A82	2.2k
R508	06–11077B05	18k
R509	06–11077A90	4.7k
R510	06–11077B23	100k
R511	06–11077B15	47k
R512	06–11077A98	10k
R513	06–11077B07	22k
R514	06–11077B23	100k
R515	06–11077A90	4.7k
R516	06–11077B03	15k
R517,518	06–11077A98	10k
R519	06–11077A90	4.7k
R520	06–11077A82	2.2k
R521	06–11077A86	3.3k
R522	06–11077A74	1k
R523	06–11077A90	4.7k
R524,525	06–11077B15	47k
R526	06–11077A98	10k
R527	06–11077A76	1.2k
R528	06–11077B15	47k
R529	06–11077A90	4.7k
R530	06–11077B07	22k
R531	06–11077B15	47k
R532,533	06–11077B07	22k
R534	06–11077A90	4.7k
R535	06–11077A98	10k
R536	06–11077B15	47k
R537,538	06–11077A90	4.7k
R542	06–11077B21	82k
R543,544	06–11077B23	100k
R545	06–11077B15	47k
R546	06–11077B07	22k
R547	06–11077A90	4.7k
R548	06–11077A50	100
R549	06–11077A74	1k
R550	06–11077A50	100
R551,552	06–11077A98	10k
R553	06–11077B07	22k
R554	06–11077A76	1.2k
Transformer		
T400	25–84083B03	audio
Integrated circuit (see note)		
U300	51–80103E02	switch filter
U301	51–80067C04	opamp
U301	51–80067C06	opamp
U302	51–83977M60	digital volume control
U400	51–84621K14	driver
U500	51–80290J04	1.5 MHz microprocessor
U501	——	radio software (see model chart)
U502	——	EEPROM software (see model chart)
U503	51–05133M01	octal latch
U504	51–05133M01	octal latch
U505	51–80067C05	opamp
U506	51–84561L42	bipolar
Voltage regulator (see note)		
VR500	48–83696E07	6.2V zener
Crystal (see note)		
Y300	48–80173D01	4 MHz
Y500	48–80173D12	4.9152 MHz

mechanical parts

	03–10943M10	tapping screw (3 x 0.5 x 8)
	03–10911A11	machine screw (3 x 0.5 x 8)
	04–84180C01	nylon shoulder washer
	07–05375P09	plated lead
	07–80042L01	hybrid support
	09–80269B03	dual socket
	09–82808R10	28 contact
	09–80269B01	dual socket
	09–82808R04	16 contact
	09–80002K01	socket
	14–80175M01	insulator shield
	14–80175M03	insulator shield
	14–80179N01	crystal pad

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	14–80206M01	heat sink insulator
	14–83820M02	heat conductive insulator
	26–80033M01	RFI shield
	26–80051K01	solder side option shield
	26–83498M01	heat sink
	28–80264K01	top entry
	28–82647K02	10 pin
	28–83485M05	male plug assembly
	29–10134A68	lug connector
	29–10134A70	lug connector
	32–80219B01	housing gasket
	37–00132026	tubing
	37–00132026	3/16 clear heatshrink tubing
	37–00132526	1/16 heatshrink tubing
	42–82891K01	transistor clip, 2 used
	43–80054K02	support spacer
	54–80072G01	circuit board label
	55–84300B04	handle
	75–80051P01	crystal pad
	75–80129N01	crystal mounting pad
	75–80144H01	vibration pads

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

Microcomputer System (Trunking Controller)

1. General

The *Systems 9000E* Trunked Controller option card occupies a single option slot inside the radio housing. The Controller option card consists of two circuit boards; each board with surface mount integrated–circuit devices. The bottom board (main board) connects to the Personality board through a 20 pin connector (J301). The main board interfaces to the radio, filters receive and transmit data, and controls the memory on the upper board. The main board has the following major components:

- U1 Microprocessor.
- U2 Semi–custom Logic IC.
- U3 Custom Analog IC.
- U4 Clock Divider.
- U10 Analog Five Volt Regulator.

The upper board (memory board) connects to the main board through a 36 pin connector (J102). The memory board has the following major components:

- U101 EEPROM (2k or 8k).
- U102 SRAM (2k).
- U103 EPROM (64k).

2. System Description

2.1 MICROCOMPUTER

Three integrated–circuit devices supply the trunking controller option with the operating program, unique user information, and communications with the radio system. An EPROM (U103) contains the operating program. EEPROM (U101) contains unique user information, such as receive and transmit frequency assignments along with fleet, subfleet, and ID information. Microcomputer (U1) communicates with the radio system.

The microcomputer (U1) is the heart of the trunking controller option. U1 contains 256 bytes of internal RAM. This RAM receives power from an unswitched 5 volt supply which saves RAM data during power on/off.

U1 performs all serial bus communications and filter control. The U1 microcomputer communicates with the radio system through the serial bus to receive button information, update displays, key the transmitter etc.

U1 directly controls PA ENABLE (P301–9) to allow faster transmit response time. U1 operates in the expanded multiplexed mode (MODE 1). The crystal frequency is 7.9488 MHz which results in an internal E–clock rate of 1.9872 MHz. This clock rate gives high computing speed and is divisible into the serial bus (9600 baud) and trunking data rates (3600 baud).

2.2 SEMI–CUSTOM LOGIC IC

The semi–custom logic IC (U2) is a custom CMOS gate array. U2 performs the following functions:

- Address de–multiplexing.
- Logic for gating R/$\overline{W}$ with E–clock to generate R/$\overline{W}$.
- Port expansion.
- EEPROM write protection.
- Address decoding.

The address de–multiplexer separates AD0–AD7 into the low order address bus and data bus. This de–multiplexer also controls internal register addressing and is used externally.

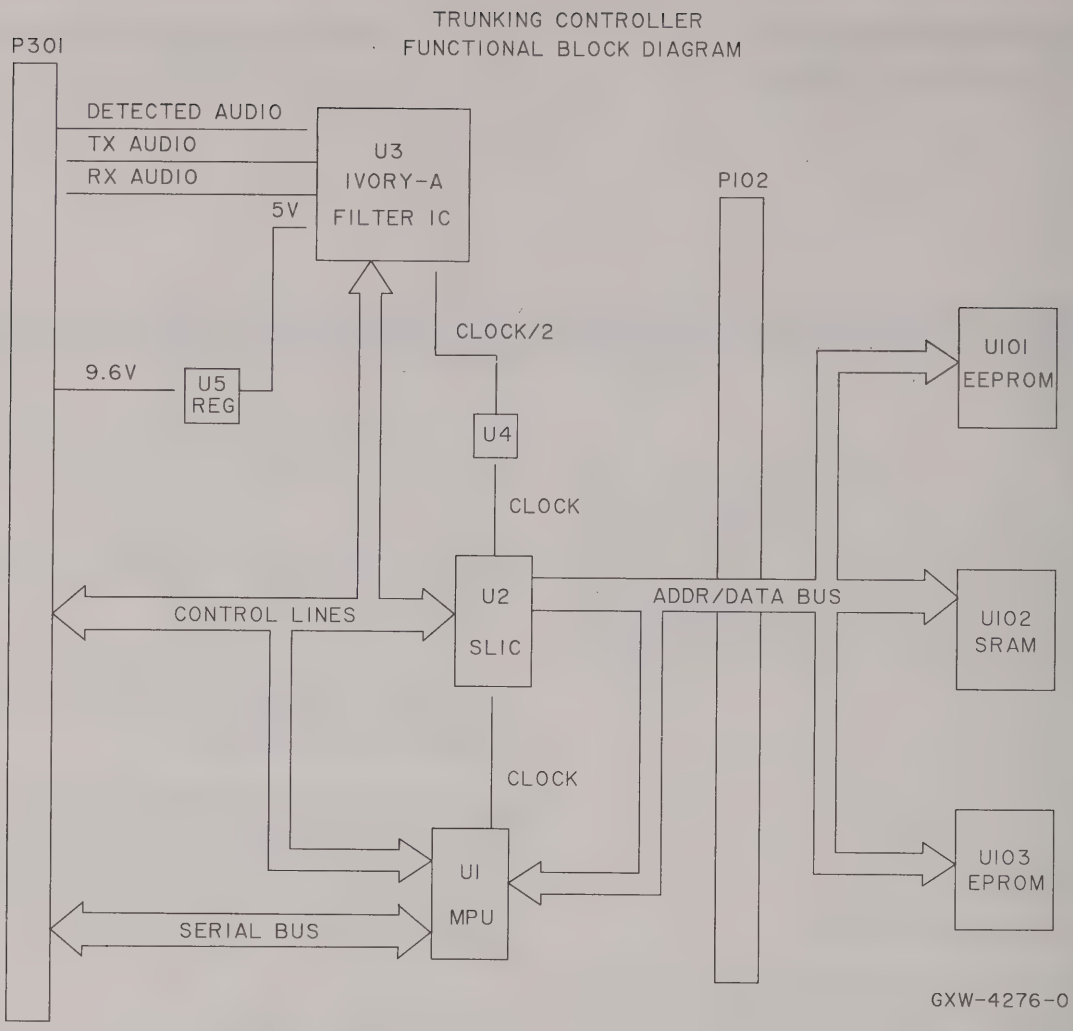


Figure 1. Trunking Controller Functional Block Diagram

Table 1. U2/U3 Control Line Levels

Note
high = Vdd – 1.0v (minimum)
low = Vss + 1.0v (maximum)

MODE OF OPERATION	U2–52 U3–27 DTMF TONE	U2–18 U3–37 R/5	U2–29 U3–41 7–#/1–6	U2–54 U3–42 TRK/DTMF	U2–8 U3–44 H/L FLTR
HIGH SPEED DATA (TX)	low	low	low	high	high
LOW SPEED DATA (TX)	low	low	low	high	low
DTMF TONES (TX)	high	low	high	low	high
HIGH SPEED DATA (RX)	low	high	low	high	high
LOW SPEED DATA (RX)	low	high	low	high	low

The R/W (U1–6) signal is AND–ed internally with the E–clock to produce R/$\overline{W}$ (U2–16). This ensures proper operation of all memories. This function is needed since the microcomputer holds the R/W line low during multiple writes to memory. Most memories need a rising edge on the write line for proper operation. U2 has three ports which are memory mapped similar to the ports on the microcomputer. This allows for filter control and for pulling the microcomputer's crystal off frequency.

U2 also provides EEPROM write protection. In order to perform a write operation to the EEPROM, a series of software conditions must be met and the Low Voltage pin (U2–12) must be true before a write can occur.

Table 1 shows the proper level of U2 control lines for various operations.

2.3 CUSTOM ANALOG IC

The custom analog chip (U3) performs the following functions:

- Transmit data filters.
- Receive data filters.
- Center slicer for receive data.
- Level shifting.
- Transmit and receive.

The transmit and receive data filters are the same. The high speed data filter is a 7 pole Bessel lowpass filter with a cutoff frequency of 2 kHz. The low speed filter is a 7 pole Chebyshev lowpass filter with a cutoff frequency of 200 Hz. Table 2 shows typical frequency response characteristics of both the high and low speed filters. These filters are switched capacitor type and are operated at half the E–clock rate or 993.6 kHz. The E–clock is divided by two by U4 (D FLIP FLOP).

Table 2. High and Low Speed Filter Frequency Response

HIGHSPEED FILTER		LOWSPEED FILTER	
FREQUENCY	dB	FREQUENCY	dB
1kHz	0	100 Hz	0
2 kHz	–3	200 Hz	–3
3 kHz	–8	205 Hz	–9.5
4 kHz	–13	250 Hz	–25
0 dB reference set at 1 kHz		0 dB reference set at 100Hz	

The low speed filter removes high frequency noise from the received signal and removes any voice energy from the low speed data which might cause distortion of the received data. The lowspeed filter attenuates harmonics of the sub–audible connect and disconnect tones during transmission and prevents the receiving mobile speaker from emitting low frequency tones.

The high speed filter removes high frequency noise from the received signal and serves as a splatter filter during the transmission of high speed data. This filter attenuates harmonics whose frequencies are greater than 2 kHz.

Figure 2 shows the internal circuits of U3 with additional external circuits shown for continuity. The DTMF TONE control line allows DTMF tones to sound in the speaker by injecting the tones onto the RX AUDIO (P301–2) line. U2 uses R/$\overline{T}$ (U2–18) to internally route the receive and transmit data. TRK/$\overline{DTMF}$ (U2–54) attenuates DTMF signal levels from normal trunking data levels. H/$\overline{L}$ FILTER (U2–8) controls whether the data goes through the high speed filter.

U3 contains the center slicer. The center slicer converts the analog filtered received data into a square digital stream. Two external capacitors are used for the two time constants: C7 for low speed data and C8 for high speed data. These two capacitors are selected by the H/$\overline{L}$ FILTER select line (U3–44). Level conversion to 0 volts and 5 volts is the last stage that receive data must pass through before being applied to a lowpass R–C filter. The R–C filter (R27 and C4) has a corner frequency of 8.8 kHz. The data is then applied to the microcomputer (U1–34).

The conversion process would be relatively simple if all received data bits had the same amplitude and did not contain any average DC voltage. However, if the data bits have different amplitudes as could happen under noisy conditions, or if the data contains a DC step as could happen while changing from an on–frequency channel to an off frequency channel, the recovery process is not as simple.

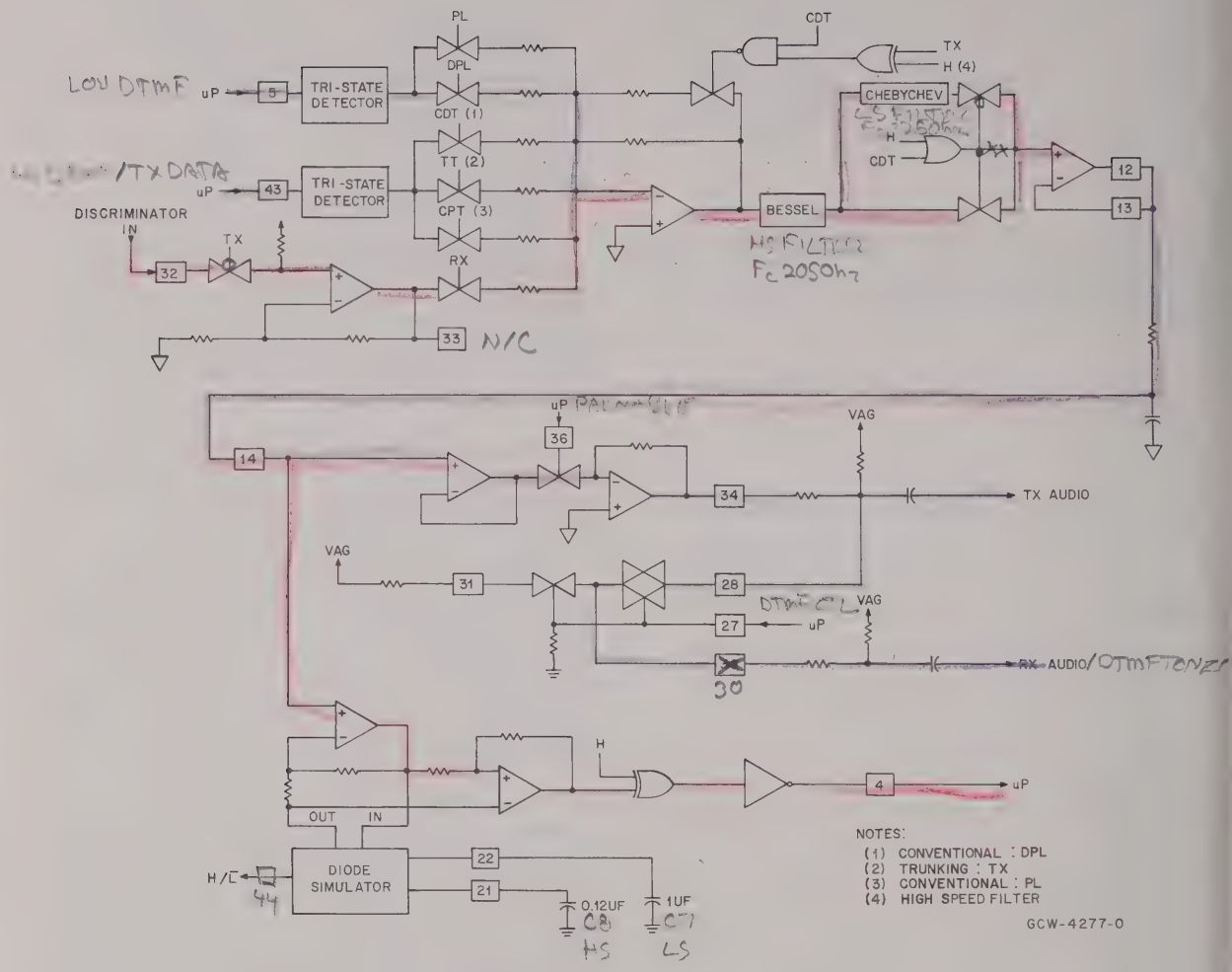


Figure 2. U3 Internal Schematic

2.4 SERIAL BUS INTERFACE

A bidirectional serial data link supplies two–way data communications between the trunked controller option card and the radio system. This serial bus consists of BUSY input/output (P301–20), $\overline{\text{TX DATA}}$ output (P301–18), and RX DATA input (P301–19).

The microcomputer (U1) controls the serial bus interface. The transmit side of the serial bus is inverted by Q1 before connection to the bus. The receive side is connected through two inverting transistors (Q13 and Q14) to the bus.

The BUSY line (P301–20) is a bidirectional line, active high when serial data is being sent on the serial bus. When the trunking controller card begins a bus transmission, $\overline{\text{BUSY}}$ $\overline{\text{OUT}}$ from the microcomputer (U1–20) goes low and Q2 inverts the signal. When an other device begins a serial bus transmission, the BUSY line (P301–20) goes high and is inverted by Q3 and the microcomputer reads the line at $\overline{\text{BUSY}}$ $\overline{\text{IN}}$ (U1–33).

The trunking controller puts 9600 baud serial data onto the serial bus via the TX DATA (SCI U1–21) line. The data is inverted by Q1 before going out the $\overline{\text{TX DATA}}$ (P301–18). Circuitry on the radio's personality board routes the data back onto the RX DATA line (P301–19) to verify the proper data

transmission. The RX DATA (P301–19) line is inverted twice (Q13 and Q14) then read by the microcomputer at $\overline{\text{RX DATA}}$ (SCI U1–20).

2.5 MEMORY MAP DECODING

The semi–custom logic IC (U2) demultiplexes the low order address/data bus AD0–AD7. U2 also contains the address decoding to select EEPROM (U101), RAM (U102), and EPROM (U103). U101 contains the specific customer programming information, U102 is a scratch pad memory for the microcomputer, and U103 contains the operating program for the microcomputer.

The memory map of U2 can be programmed to allow different allocations of EEPROM, RAM, and EPROM. The maximum addressable memory sizes are as follows.

- EEPROM– 16k (A0–A13).
- SRAM– 32k (A0–A14).
- EPROM– 64k (A0–A15).

Table 3. SRAM and EPROM Jumper Placement

SRAM	JU104	JU105	JU106	JU107
2k (24 PIN)	IN	OUT	IN	OUT
8k/16k/32k (28 PIN)	OUT	IN	OUT	IN

note: JU108 is always IN

EPROM	JU101	JU102	JU103
8k or 16k	OUT	IN	OUT
32k	IN	IN	OUT
64k	IN	OUT	IN

3. Audio Filters

The trunked system signalling format requires the processing of both high and low speed data in both the transmit and receive modes. The custom analog IC (U3) contains the high and low speed filters, center slicer, and DTMF filters. The microcomputer controls the filter switching.

The high speed data path must be selected when transmitting the inbound signalling word (ISW) on the control channel, or when transmitting the 1800 Hz acknowledge tone on the voice channel. When transmitting the low speed connect or disconnect tone on the voice channel, the microcomputer selects the lowspeed data path.

The control channel background word and the Out bound Signalling Word (OSW) and the voice channel high speed handshake signal must be routed through the high speed data path and the center slicer, then back to the microcomputer for decoding when in the receive mode. The voice channel low speed handshake and fail soft word must be routed through both the low and high speed filters before entering the microcomputer via the center slicer.

3.1 RECEIVE AUDIO

The discriminator audio is attenuated by about 18 dB before being applied to DET AUDIO (U3–32). The DET AUDIO input can have a minimum input impedance of 11k ohms. This input impedance combined with the DC blocking capacitor (C1) gives a minimum low frequency corner of about 1.5 Hz. The received signal then is routed through U3.

3.2 TRANSMIT AUDIO

The Trunked controller injects trunking data and DTMF on TX AUDIO (P301–3). The data is routed through the transmit option buffer U301–A. The output of U301–A should be approximately the same level at TX MOD (U3–34). The TX Flat option is chosen through U300. From U300–21 to U300–15 there is a +7.5 dB gain with a frequency response of 2 Hz to 6 kHz.

The output of the TX Flat switch (U300–15) is routed to two different ports of the VCO. The first is the VCO MOD port, and the second is the REFERENCE MOD port. The TX Flat signal routing to the VCO MOD port is from the output of the TX Flat switch. The signal at U300–15 is attenuated by –9.5 dB. The attenuated signal is input to U300–13 where it passes through a unity gain buffer. The output for U300–13 goes to the VCO MOD port via the compensation adjust potentiometer and a 10 kHz low pass filter. The TX Flat routing to the reference oscillator goes through –15.8 dB of attenuation. The TX Flat signal passes through a DC blocking capacitor C105, then to the REFERENCE MOD port of the VCO.

3.3 RESET

The $\overline{\text{RESET}}$ line (U1–17) from the microcomputer is connected to the bus RESET (P301–17) through Q6. The personality board generates a reset on power up or when required. The personality board can also reset the trunking controller microcomputer (U1–17). U1 contains a Computer Operating Properly (COP) watchdog feature used as an internal watchdog timer. The watchdog timer causes a system reset if not writ ten to within 16 msec. U1 also generates a reset if the E–clock is lost, or if its frequency falls below 200 kHz.

U1 has the capability to reset the entire system by taking RESET OUT (U1–31) high. RESET OUT is inverted twice by Q15 and Q4, then passed through bus RESET (P301–17). This also resets the trunking controller by the feedback from Q6 to U1–17.

3.4 PA ENABLE

The microcomputer has direct control over the PA ENABLE line (P301–9). This provides faster response times. Jumpers on the personality board allow a pin on the option connector to function as a PA ENABLE (JU505 IN) line or a crystal pull (JU504 IN) line.

Since the trunking controller card uses a different crystal frequency than the personality board, it needs to pull its crystal at different frequencies.

The PA ENABLE line also connects to U3 to allow transmit data to be sent through the transmit filters.

3.5 CRYSTAL PULL

The crystal frequency needs to be varied slightly for certain harmonics of the crystal. The crystal pull circuit is used to avoid radio self–quieters.

In the normal state, U2–22 is low and supplies DC bias to two pin diodes (CR1 and CR2). This bias puts CR1 and CR2 in the on state. Capacitor C22 then supplies an AC ground for the crystal.

If instead the crystal needs to be pulled off frequency, U2–22 goes high to DC bias CR1 and CR2 off. This causes the crystal to be at AC ground through capacitors C10 and C11, and resistors R54 and R55.

3.6 LOW VOLTAGE DETECTION

Q5 and Q9 form a low voltage detection circuit. The common circuits board requires the 9.6V supply to fall before SW +5V falls. Thus, Q5 saturates when 9.6V falls to approximately 7.8 volts DC. This saturates Q9 which is attached to $\overline{\text{XIRQ}}$ (U1–18) and $\overline{\text{LOW VOLTAGE DETECT}}$ (U2–12). $\overline{\text{XIRQ}}$ sends the microcomputer (U1) into the stop mode to prevent any accidental writes to the RAM. $\overline{\text{LOW VOLTAGE DETECT}}$ when low, does not allow EEPROM writes.

4. Theory of Operation

4.1 SYSTEM INITIALIZATION

The microcomputer is placed in the reset mode for approximately 130 milliseconds, via the bus RESET (P301–17), when the radio system initially powers up. The microcomputer powers up in operating mode 1 (expanded bus mode).

During initialization, the EEPROM (U101), SRAM (U102), and EPROM (U103) are checked for proper operation. Should an error be found during the system's self check, an error message displays on the control unit. See the troubleshooting trees at the end of this section for definitions of error messages.

4.2 SEARCHING FOR A CONTROL CHANNEL

After initialization, the microcomputer reads the code plug and retrieves the data stored in RAM (U102). U102 contains the four control channel frequencies, the system ID, and the fleet/subfleet assignments.

The processor generates an eight bit parallel address on the address/data bus (AD0–AD7), the high order address (to be decoded), and selects the EPROM (U103).

The instruction contained at the address applied to U103 is placed on the D0–D7 data output lines when the $\overline{\text{CE}}$ input at U103–23 is low. The microcomputer reads and acts upon the instruction using the data stored in RAM (U102) to send the radio a command (via the serial bus) to load the synthesizer to receive on the first control channel frequency.

The microcomputer listens on the channel when this operation is completed. Activity on the channel just selected is routed through the high speed filter and the center slicer of U3.

If the channel selected contains a background word and an Outbound Signalling Word (OSW), the microcomputer synchronizes to this data and waits for the ID contained in the background word and the OSW. If the ID matches the ID retrieved from the code plug, the radio remains locked on this channel.

If the channel just selected contains only noise or does not contain the proper ID in the background word, the microcomputer repeats the entire sequence for the next control channel. (ie; retrieve information from RAM, transfer the information to the radio, listen for the proper ID and background word, and lock on channel or repeat the process). The same process is repeated for all remaining control channels until the proper control channel is located.

All frequency selections follow the same process. The only difference is what initiates the channel change command. The operator (by initiating a call) or a command from the base repeater station.

4.3 RECEIVING A TRANSMISSION

When a mobile unit receives a transmission, the background word and OSW on the control channel contains information that directs the mobile unit to change frequency to a vacant voice channel. The microcomputer recognizes this command and initiates the transfer of the channel information to the radio via the serial bus.

Next the microcomputer (U1) listens to the handshake word present on the voice channel. U1 first tries to read the handshake word using the high speed filter. If the data is unintelligible, U1 switches to the low speed filter and tries to read the data again.

If intelligible data is obtained, U1 compares the fleet and subfleet data contained in the handshake word with data stored in the code plug. If intelligible data is not obtained, U1 reverts to the control channel and tries the background word and OSW sequence again.

Once intelligible data and a match between the data in the handshake word and data in the code plug is obtained, a serial bus command goes to the radio and the audio unmutes.

The high speed handshake does not occur in trunking systems equipped for fast access time. In this case, the audio unmutes immediately upon reaching the voice channel. If the data contained in the low speed word does not match the data in the code plug, the microcomputer reverts to the control channel and tries the background word and OSW sequence again.

4.4 MAKING A CALL

A mobile unit, receiving the control channel, keys up and sends a request Inbound Signalling Word (ISW) on the control channel when the PTT is pressed. The ISW is sent in a precise time slot relative to the OSW time frame. The request ISW contains information about the mobile ID, fleet and subfleet assignment, and the purpose (system wide call, fleet wide call, subfleet call, or individual call) for the channel request. The ISW is 78 bits long and sent at 3600 bps for a total length of 23 milliseconds.

The central controller directs the mobile unit to a particular voice channel via the OSW. U1 recognizes the channel change information in the OSW, transfers the channel information to the radio, and listens for the handshake word on the voice channel. U1 first tries to read the handshake word using the high speed filter. If the data is unintelligible, U1 switches to the low speed filter and tries to read the data again.

If intelligible data is obtained, U1 compares the fleet and subfleet data contained in the handshake word with data stored in the code plug.

If a match is obtained, U1 sends a serial bus command to the radio to key up the radio transmitter. U1 then sends an 80 millisecond burst of 1800 Hz acknowledge tone.

No handshake is performed if the system is configured for fast access. Instead, the transmitter immediately keys up upon reaching the vacant voice channel.

The mobile unit first sends 200 milliseconds of disconnect tone before turning off the transmitter when the mobile PTT button is released. The mobile then listens for any reply. If the reply occurs within the hang time of the repeater, the mobile remains on that voice channel. If the reply is made after the repeater drops out, the mobile unit returns to the control channel and is assigned a new voice channel for the reply.

5. Signalling Definitions

5.1 RECEIVE MODE

Receive low speed data includes the following.

- Low speed handshake connect word at 150 baud (voice channel).
- Low speed disconnect word at 300 baud (voice channel).

Receive high speed data include the following.

- Background data word at 3600 baud (control channel).
- Outbound Signalling Word (OSW) at 3600 baud (control channel).
- High speed handshake at 3600 baud (voice channel; if configured).

The receive data signals enter the trunking controller board at DET AUDIO (P301–4). The time sequence and routing control of these signals is a direct function of U1. The implementation function of routing these signals through the appropriate filters and center slicer stages is performed by U3.

5.2 TRANSMIT MODE

Transmit low speed data includes the following.

- Connect tone (voice channel; typically 105 Hz).
- Disconnect tone at 163 Hz (voice channel).

Transmit high speed data includes the following.

- Inbound Signalling Word (ISW) at 3600 baud (control channel).
- Acknowledge word at 1800 Hz (voice channel, if configured).

The transmit data signals leave the trunking controller board at $\overline{\text{TX DATA}}$ (P301–3). The time sequence and routing control is a direct function of U1. The implementation function of routing these signals through the appropriate filter stages is performed by U3.

6. Troubleshooting Procedure

See the schematics and troubleshooting charts at the end of this section.

The following information is to aid in the understanding of the interaction of the trunking controller option during typical serial bus communications with radio and control unit.

6.1 MODE CHANGE FROM CONVENTIONAL TO TRUNKED MODE

- Radio sends mode update from radio to all other microprocessors on the serial bus.
- Radio sends control unit mode number display.
- Trunking controller mutes discriminator.
- Trunking controller sends radio control channel.
- Trunking controller verifies control channel audio.
- Trunking controller sets up audio routing to send Inbound Signalling Word (ISW).

6.2 INITIATING A PTT

- PTT button press sent from control unit to all other microprocessors on the serial bus.
- Trunking controller tells radio to key transmitter for ISW.
- Radio tells control unit to light TX indicator.
- Trunking controller enables PA and sends ISW.
- Trunking controller tells radio to de–key.
- Radio tells control unit to turn off TX indicator.
- Trunking controller sends receive channel number to radio.
- Trunking controller looks for Outbound Signalling Word (OSW).
- Trunking controller sends voice channel number to radio.
- Trunking controller tells radio to key transmitter.
- Radio tells control unit to light TX indicator.

6.3 RELEASING PTT

- PTT release sent from control unit to all other microprocessors on the serial bus.
- Trunking controller sends disconnect tone.
- Trunking controller tells radio to de–key.
- Radio tells control unit to turn TX indicator off.
- Trunking controller sends control channel number to radio.
- Trunking controller sets up audio routing for ISW.

7. Field Programming

The *Systems 9000E* radio uses EEPROM (Electrically Erasable Programmable Read Only Memory) devices to store information about frequencies, squelch codes, time–out–timer durations, list names and other parameters.

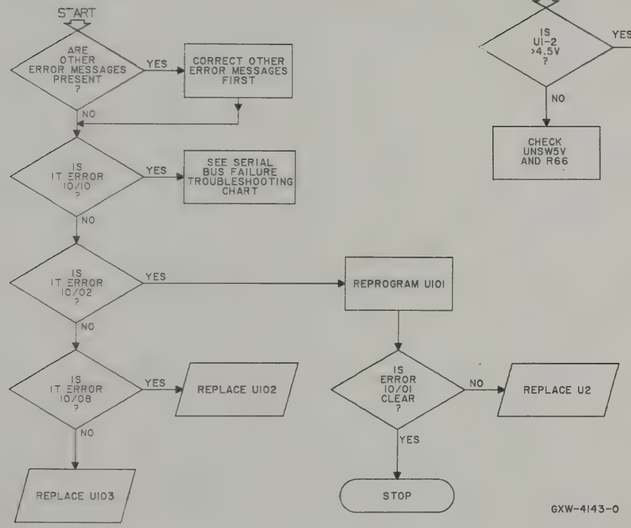
The *SYNTOR X 9000E* radio system may be programmed in the field any number of times. Programming is accomplished without removing the EEPROM from the radio. An IBM PC, XT, or AT computer connects to the radio through the front connector. The user friendly software supplies prompts for easy programming. The prompts on the computer display lead you through the programming procedure.

The following hardware and software items are available through Motorola C & E Parts Department. Use the Motorola part number when ordering.

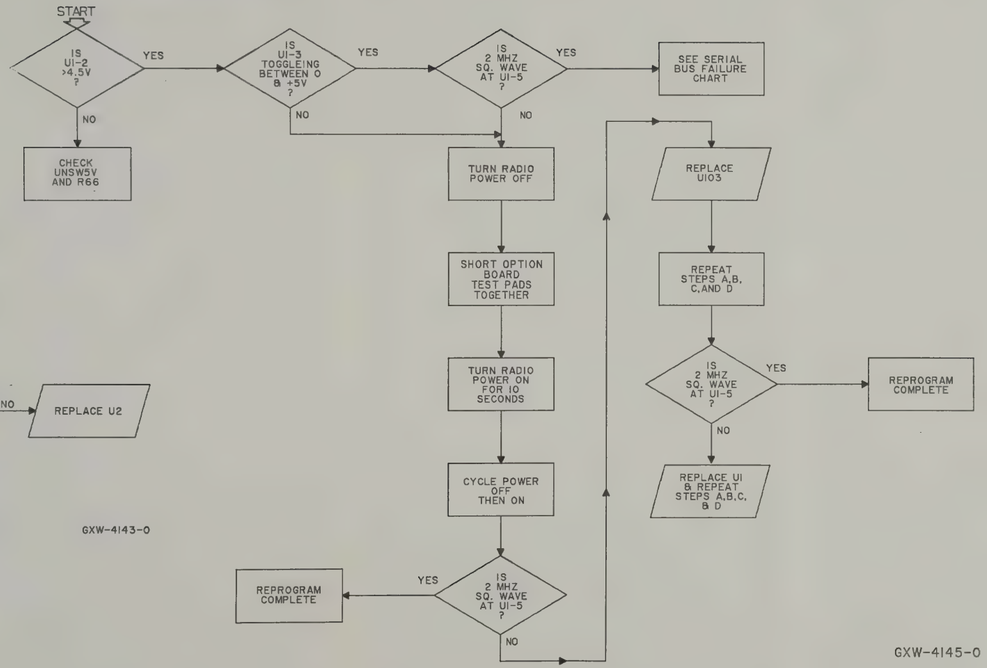
DESCRIPTION	PART NUMBER
Radio Interface Box (RIB)	01–80353A74
Cable – Radio To RIB	01–80353A75
Cable – IBM Computer To RIB	
IBM PC, XT	01–80357A44
IBM AT	01–80357A64
Software Programming Package	
5 1/4" Floppy Disk Format (800 MHz)	RVN4009
3 1/2" Floppy Disk Format (800 MHz)	RVN4010
5 1/4" Floppy Disk Format (UHF)	HVN4045
3 1/2" Floppy Disk Format (UHF)	HVN4046

Option Error Messages

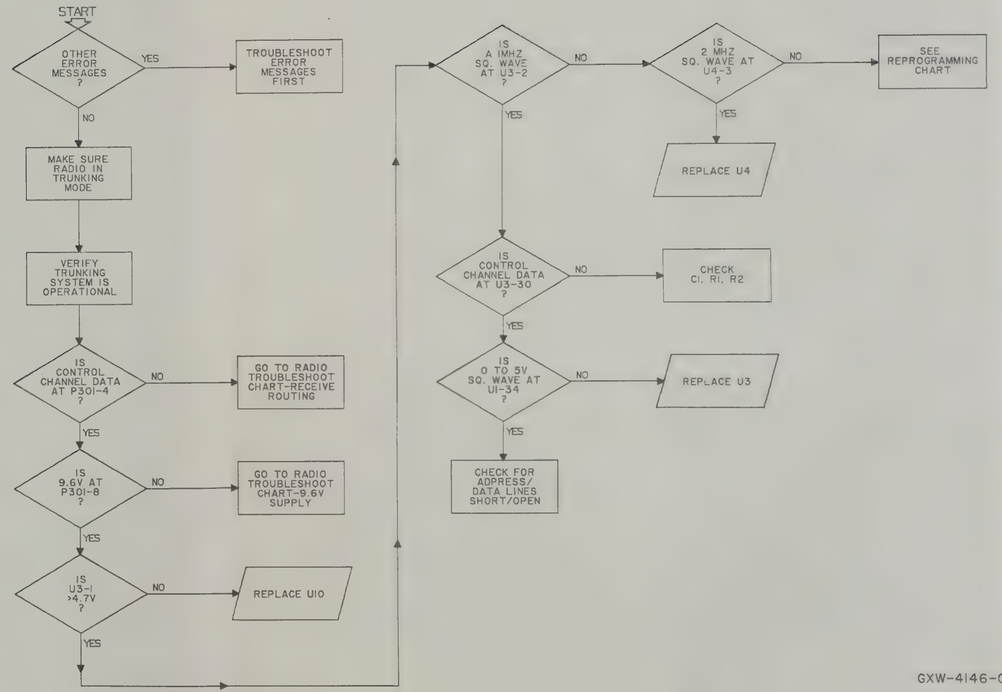
ERROR 10/01
ERROR 10/02
ERROR 10/08
ERROR 10/10



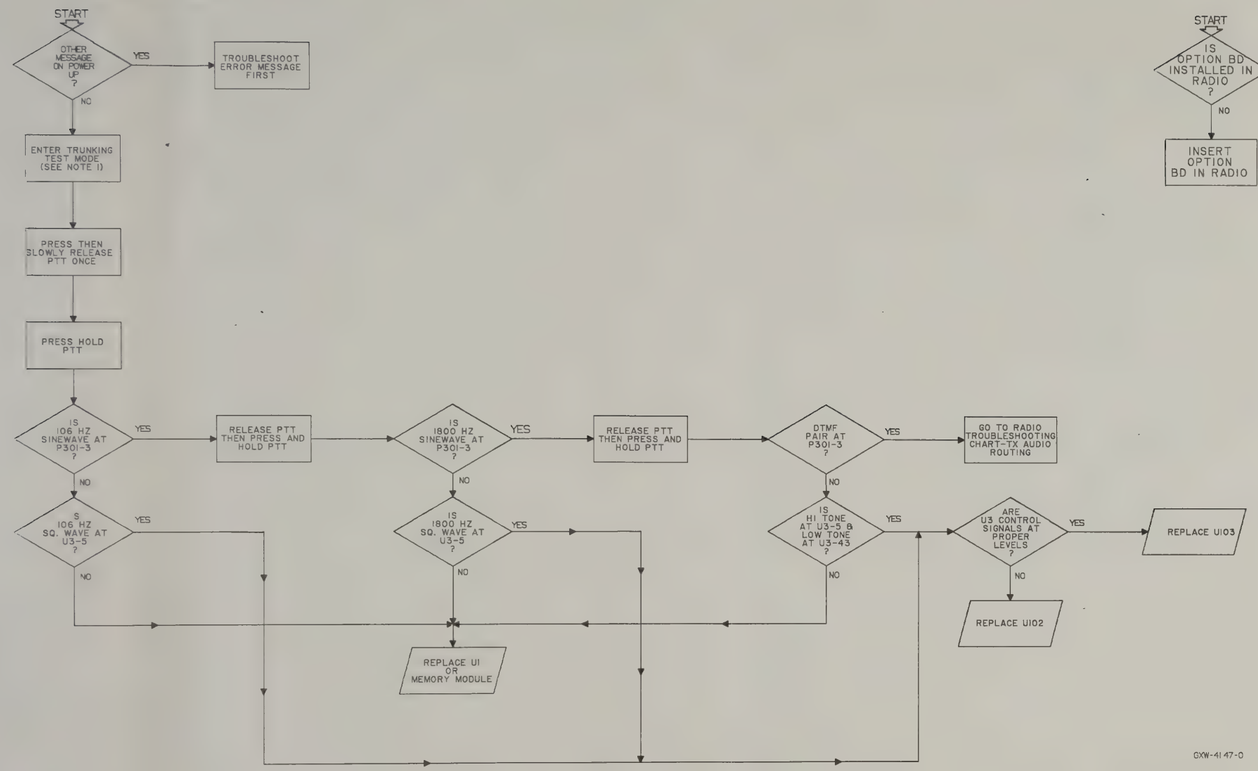
U100 Reprogramming Chart



Trunking Data Receive Failure

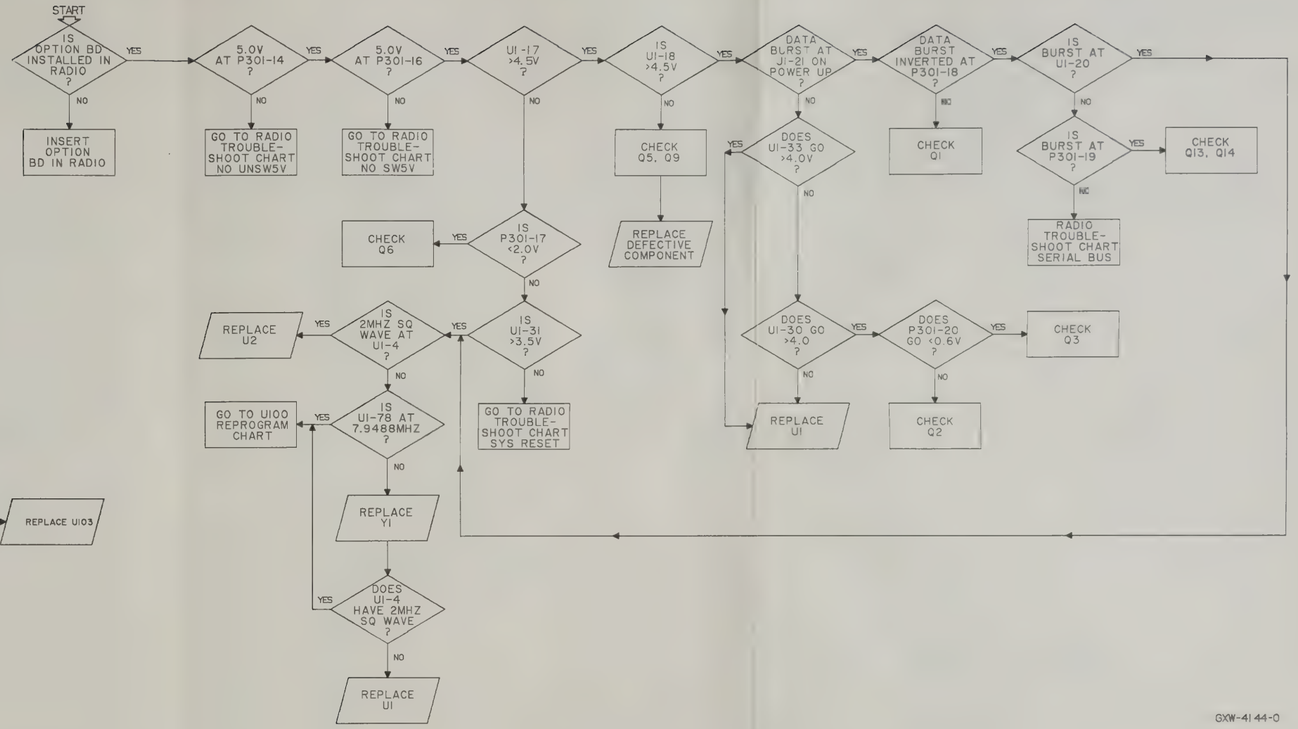


Not Transmitting



GXW-4147-O

Serial Bus Failure



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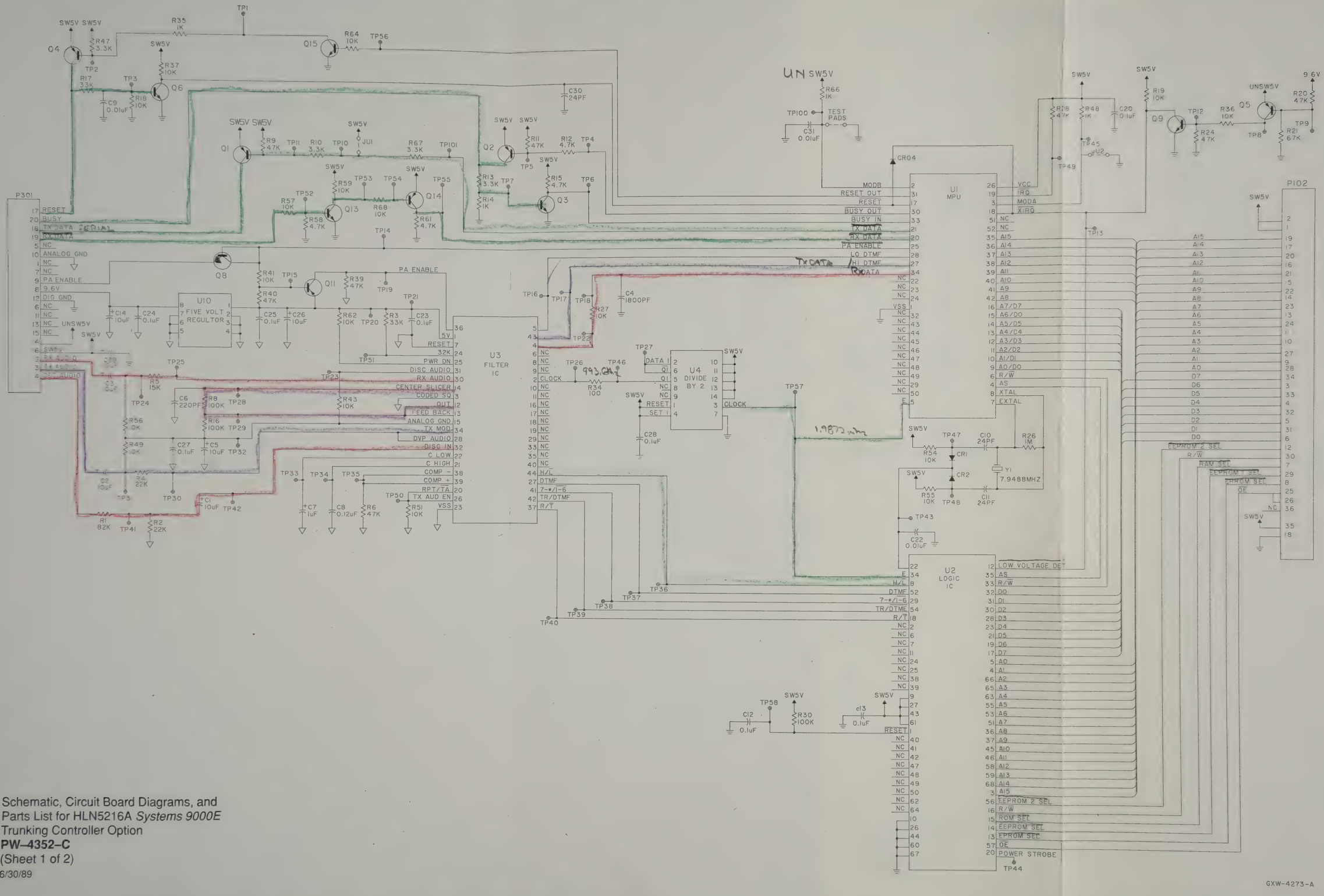
Troubleshooting Charts for
Systems 9000E Trunking Controller Option
(Sheet 2 of 2)
PW-4351-O
4/30/87



Schematic, Circuit Board Diagrams, and
Parts List for HLN5216A *Systems 9000E*
Trunking Controller Option
PW–4352–C
(Sheet 1 of 2)
6/30/89

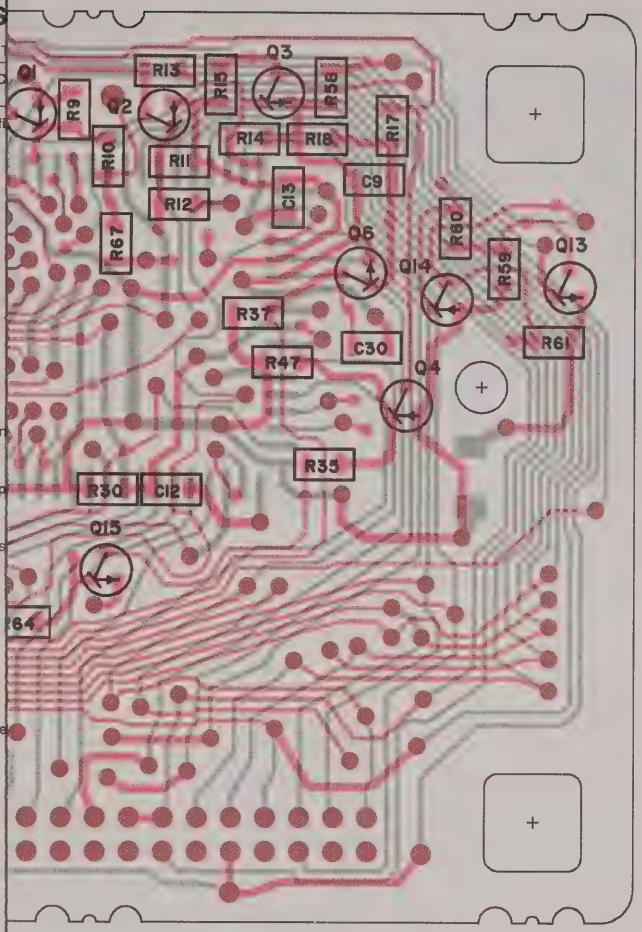
GXW-4273-A

parts

HLN5216A T

REFERENCE SYMBOL
capacitor, fi
C1–3
C4
C5
C6
C7
C8
C9
C10,11
C12,13
C14
C20
C22
C23–25
C26
C27,28
C29
C30
C31
diode (see n
CR1,2
CR4
connector p
P102
P301
transistor (s
Q1,2
Q3
Q4,5
Q6
Q8
Q9
Q11
Q13
Q14
Q15
resistor, fixe
R1
R2
R3
R4
R5
R6
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18,19
R20
R21
R24
R26
R27
R28
R30
R34
R35
R36,37
R39,40
R41
R43
R47
R48
R49
R51
R54–57
R58
R59,60
R61
R62
R64
R66
R67
integrated ci
U1
U2
U3
U4
U10
crystal (see n
Y1

note: For be
Motorola part



GAW-4261-O
GAW-4264-O
GXW-4265W02-O

SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and
Parts List for HLN5216A *Systems 9000E*
Trunking Controller Option
PW–4352–C
(Sheet 2 of 2)
6/30/89

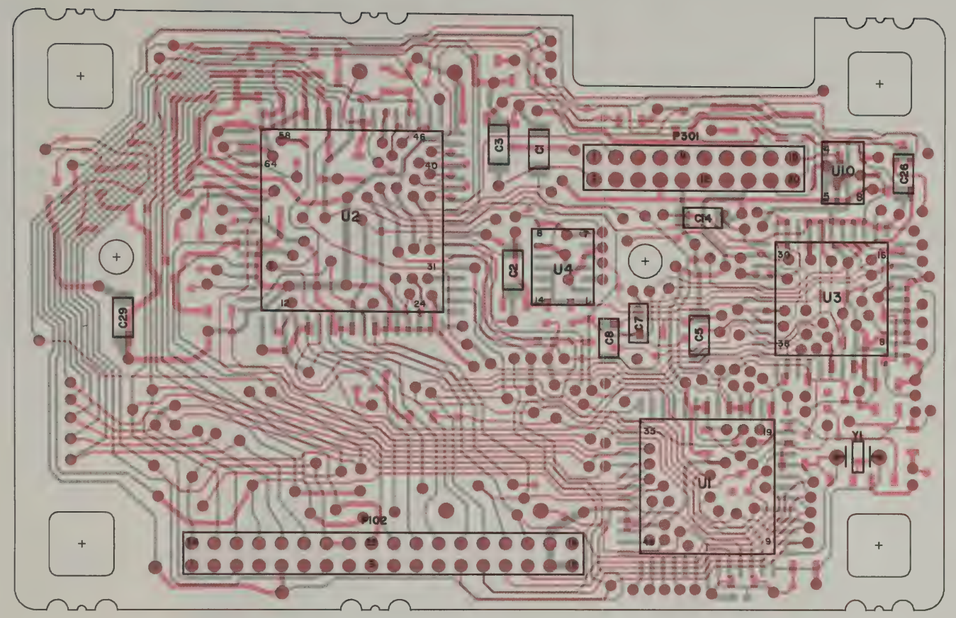
parts list

HLN5216A Trunking Controller Circuit Board — MXW–4152–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C1–3	23–62998B73	10, ±20%, 16V, tantalum
C4	21–13740B78	.0018, ±5%
C5	23–62998B73	10, ±20%, 16V, tantalum
C6	21–13740B57	.220 pF, ±5%
C7	23–62998B09	1, ±10%, 16V, tantalum
C8	21–80248M01	.012
C9	21–13741B45	.01
C10,11	21–13740B34	24 pF, ±5%
C12,13	21–11032B13	.1, +80, –20%
C14	23–62998B73	10, +20%, 16V, tantalum
C20	21–11032B13	.1, +80, –20%
C22	21–13741B45	.01
C23–25	21–11032B13	.1, +80, –20%
C26	23–62998B73	10, ±20%, 16V, tantalum
C27,28	21–11032B13	.1, +80, –20%
C29	23–62998B73	10, ±20%, 16V, tantalum
C30	21–13740B34	24 pF, ±5%
C31	21–13741B45	.01
diode (see note)		
CR1,2	48–80142L01	silicon
CR4	48–80154K01	hot carrier
connector plug		
P102	09–80085M01	terminal
P301	28–80267M02	male header
transistor (see note)		
Q1,2	48–80141L01	PNP
Q3	48–80141L02	NPN
Q4,5	48–80141L01	PNP
Q6	48–80141L02	NPN
Q8	48–80141L01	PNP
Q9	48–80141L02	NPN
Q11	48–80141L01	PNP
Q13	48–80141L02	NPN
Q14	48–80141L01	PNP
Q15	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt, (unless otherwise stated)		
R1	06–11077B21	82k
R2	06–11077B07	22k
R3	06–11077B11	33k
R4	06–11077B07	22k
R5	06–11077B03	15k
R6	06–11077B15	47k
R8	06–11077B23	100k
R9	06–11077B15	47k
R10	06–11077A86	3.3k
R11	06–11077B15	47k
R12	06–11077A90	4.7k
R13	06–11077A86	3.3k
R14	06–11077A74	1k
R15	06–11077A90	4.7k
R16	06–11077B23	100k
R17	06–11077B11	33k
R18,19	06–11077A98	10k
R20	06–11077B15	47k
R21	06–11077B19	68k
R24	06–11077B15	47k
R26	06–11077B47	1 MEG
R27	06–11077A98	10k
R28	06–11077B15	47k
R30	06–11077B23	100k
R34	06–11077A50	100
R35	06–11077A74	1k
R36,37	06–11077A98	10k
R39,40	06–11077B15	47k
R41	06–11077A98	10k
R43	06–11077A98	10k
R47	06–11077A86	3.3k
R48	06–11077A74	1k
R49	06–11077A98	10k
R51	06–11077A98	10k
R54–57	06–11077A98	10k
R58	06–11077A90	4.7k
R59,60	06–11077A98	10k
R61	06–11077A90	4.7k
R62	06–11077A98	10k
R64	06–11077A98	10k
R66	06–11077A74	1k
R67	06–11077A86	3.3k
integrated circuit (see note)		
U1	51–97024A01	microcomputer
U2	51–82862N09	gate array
U3	51–83977M80	trunking filter
U4	51–80177M01	dual flip–flop
U10	51–82276R13	volt regulator
crystal (see note)		
Y1	48–80113K04	7.9488 MHz

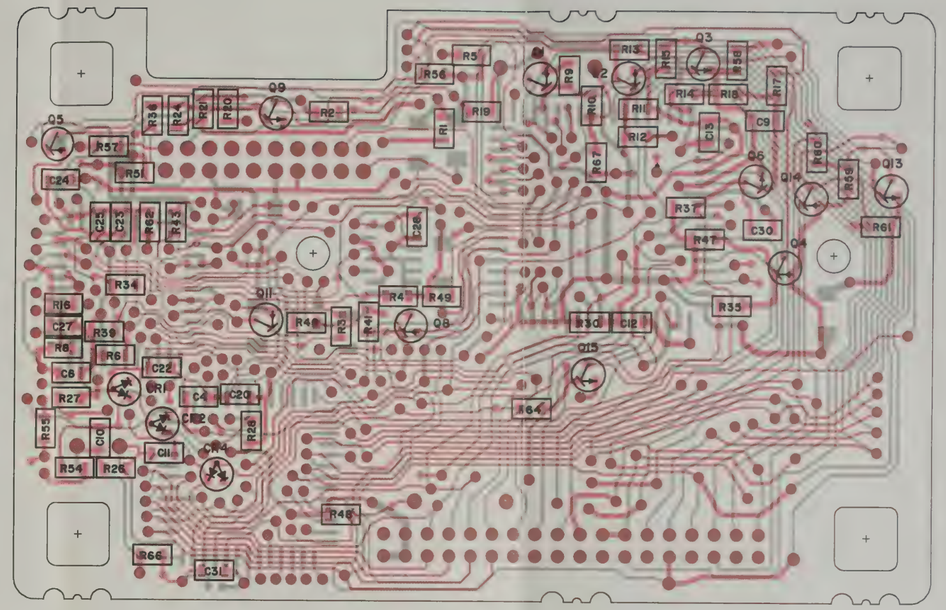
6/30/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



COMPONENT SIDE VIEW

SOLDER SIDE	RED	GAW-4261-O
COMPONENT SIDE	GRAY	GAW-4264-O
OVERLAY	—	GXW-4265W01-O



SOLDER SIDE	RED	GAW-4261-O
COMPONENT SIDE	GRAY	GAW-4264-O
OVERLAY	—	GXW-4265W02-O

SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and
Parts List for HLN5216A *Systems 9000E*
Trunking Controller Option
PW–4352–C
(Sheet 2 of 2)
6/30/89

parts list

HLN5365A Trunking Memory Board (2k)
HLN5366A Trunking Memory Board (8k) MXW–4153–C

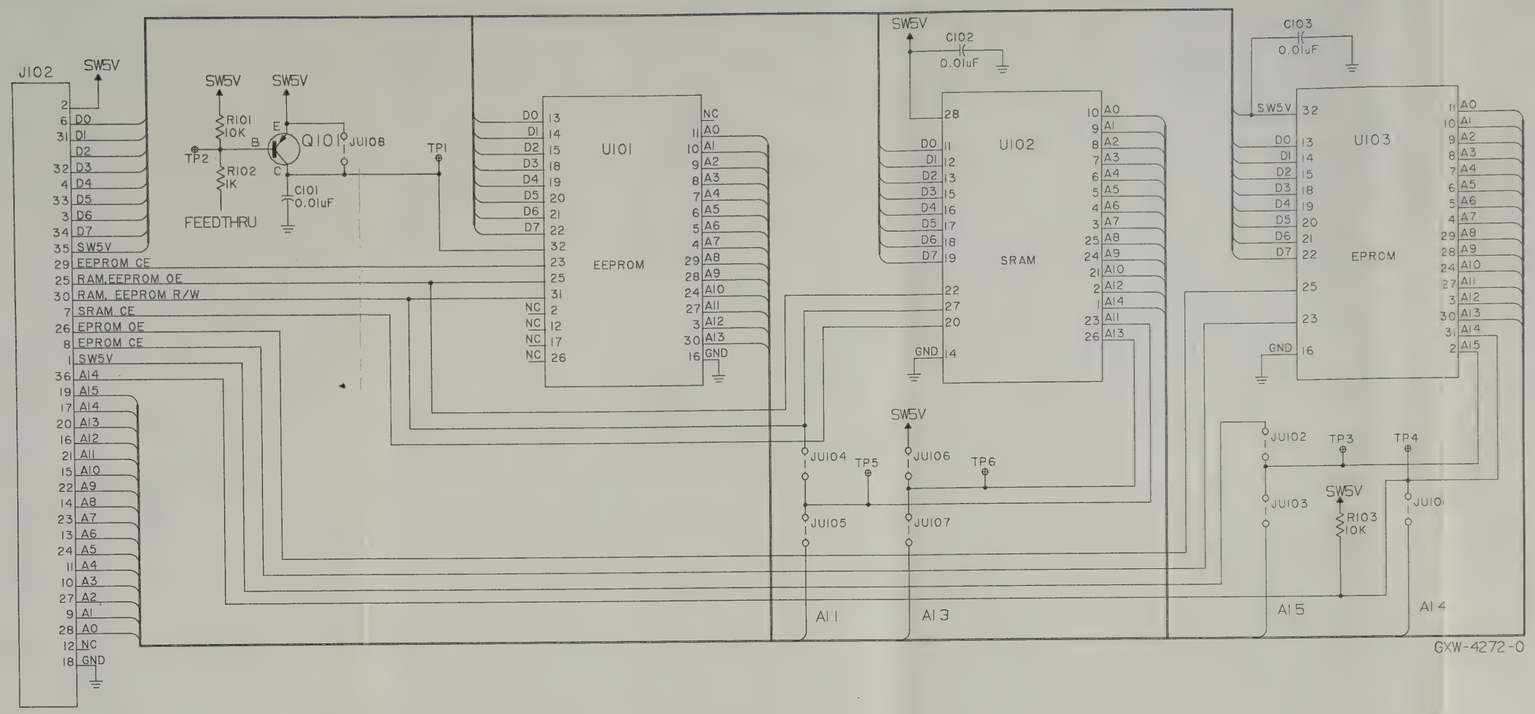
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101–103	21–13741N45	.01
connector		
J101	09–80086M01	socket, 13 contacts
jumper		
JU101	06–11077A01	0 ohm
JU103	06–11077A01	0 ohm
JU104	06–11077A01	0 ohm
JU106	06–11077A01	0 ohm
JU109	06–11077A01	0 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R103	06–11077A98	10k
integrated circuit (see note)		
U101	51–907014A11	2k EEPROM (HLN5365C)
	51–907014A10	8k EEPROM (HLN5366C)
U102	51–80049K02	RAM
U103	51–97032A01	32k EPROM
non–referenced parts		
	43–80036M01	standoff, 2 used
	55–80096M01	handle

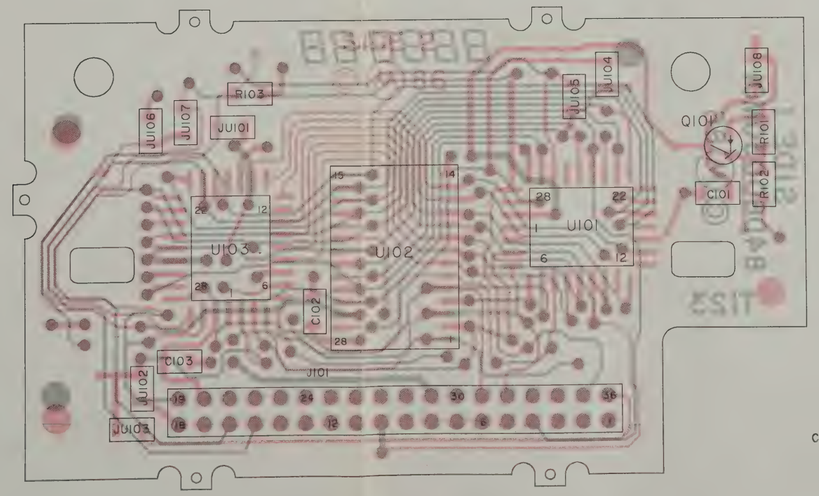
6/30/89

note: For best performance, order diodes, transistors, and intergrated circuit devices by Motorola part number.

JUMPER TABLE

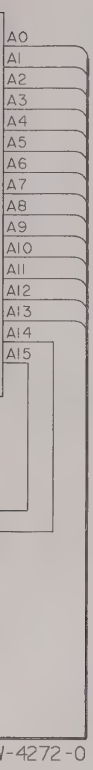
KIT	JUMPER AND STATUS							
	JU101	JU102	JU103	JU104	JU105	JU106	JU107	JU108
HLN5365A	IN	OUT	IN	IN	OUT	IN	OUT	IN
HLN5366A	IN	OUT	IN	IN	OUT	IN	OUT	IN





SOLDER SIDE GAW–4267–O
COMPONENT SIDE GAW–4270–O
OVERLAY GXW–4271–A

Schematic, Circuit Board Diagrams, and Parts List for HLN5365A and HLN5366A
Systems 9000E Trunking Controller Option
PW–6739–O
6/30/89



-4272-0

parts list

HLN5365B Trunking Memory Board (2k)
HLN5366B Trunking Memory Board (8k) MXW–6601–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101–103	21–13741N45	.01
connector		
J101	09–80086M01	socket
jumper		
JU101	06–11077A01	0 ohm
JU103	06–11077A01	0 ohm
JU104	06–11077A01	0 ohm
JU106	06–11077A01	0 ohm
JU108	06–11077A01	0 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R103	06–11077A98	10k
integrated circuit (see note)		
U101	51–907014A11	2k EEPROM (HLN5365B)
	51–907014A10	8k EEPROM (HLN5366B)
U102	51–80049K02	RAM
U103	51–97031A01	32k EPROM
	non–referenced parts	
	43–80036M01	standoff, 2 used
	55–80096M01	handle

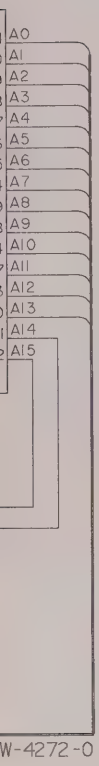
6/30/89

note: For best performance, order diodes, transistors, and intergrated circuit devices by Motorola part number.

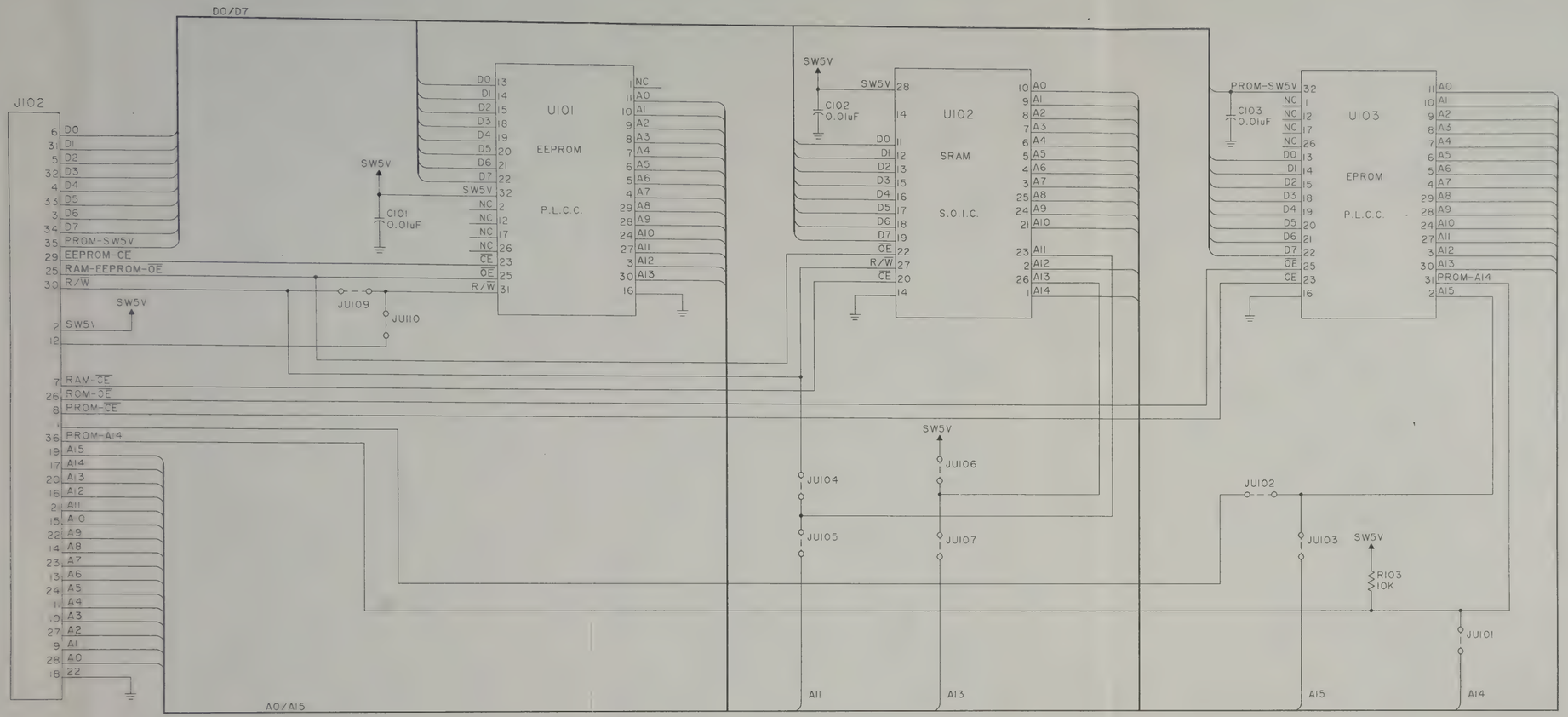
JUMPER TABLE

KIT	JUMPER AND STATUS							
	JU101	JU102	JU103	JU104	JU105	JU106	JU107	JU108
HLN5365B	IN	OUT	IN	IN	OUT	IN	OUT	IN
HLN5366B	IN	OUT	IN	IN	OUT	IN	OUT	IN

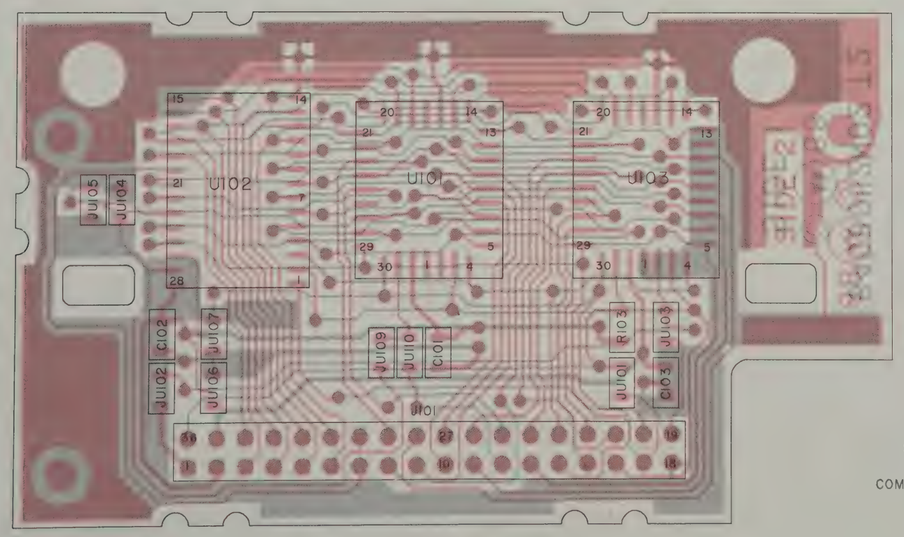
Schematic, Circuit Board Diagrams, and
Parts List for HLN5365B and HLN5366B
Systems 9000E Trunking Controller Option
PW–6740–O
6/30/89



W-4272-0



GXW-6602-O



SOLDER SIDE GAW-6598-O

COMPONENT SIDE GAW-6599-O

OVERLAY GXW-6600-O

parts list

HLN5365B Trunking Memory Board (2k)
HLN5366B Trunking Memory Board (8k) MXW-6601-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101–103	21–13741N45	.01
connector		
J101	09–80086M01	socket
jumper		
JU101	06–11077A01	0 ohm
JU103	06–11077A01	0 ohm
JU104	06–11077A01	0 ohm
JU106	06–11077A01	0 ohm
JU108	06–11077A01	0 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R103	06–11077A98	10k
integrated circuit (see note)		
U101	51–907014A11	2k EEPROM (HLN5365B)
	51–907014A10	8k EEPROM (HLN5366B)
U102	51–80049K02	RAM
U103	51–97031A01	32k EPROM
	non–referenced parts	
	43–80036M01	standoff, 2 used
	55–80096M01	handle

6/30/89

note: For best performance, order diodes, transistors, and intergrated circuit devices by Motorola part number.

JUMPER TABLE

KIT	JUMPER AND STATUS							
	JU101	JU102	JU103	JU104	JU105	JU106	JU107	JU108
HLN5365B	IN	OUT	IN	IN	OUT	IN	OUT	IN
HLN5366B	IN	OUT	IN	IN	OUT	IN	OUT	IN

Schematic, Circuit Board Diagrams, and Parts List for HLN5365B and HLN5366B *Systems 9000E* Trunking Controller Option
PW–6740–O
6/30/89

parts list

HLN5365C Trunking Memory Board (2k)
HLN5366C Trunking Memory Board (8k) MXW-6606-C

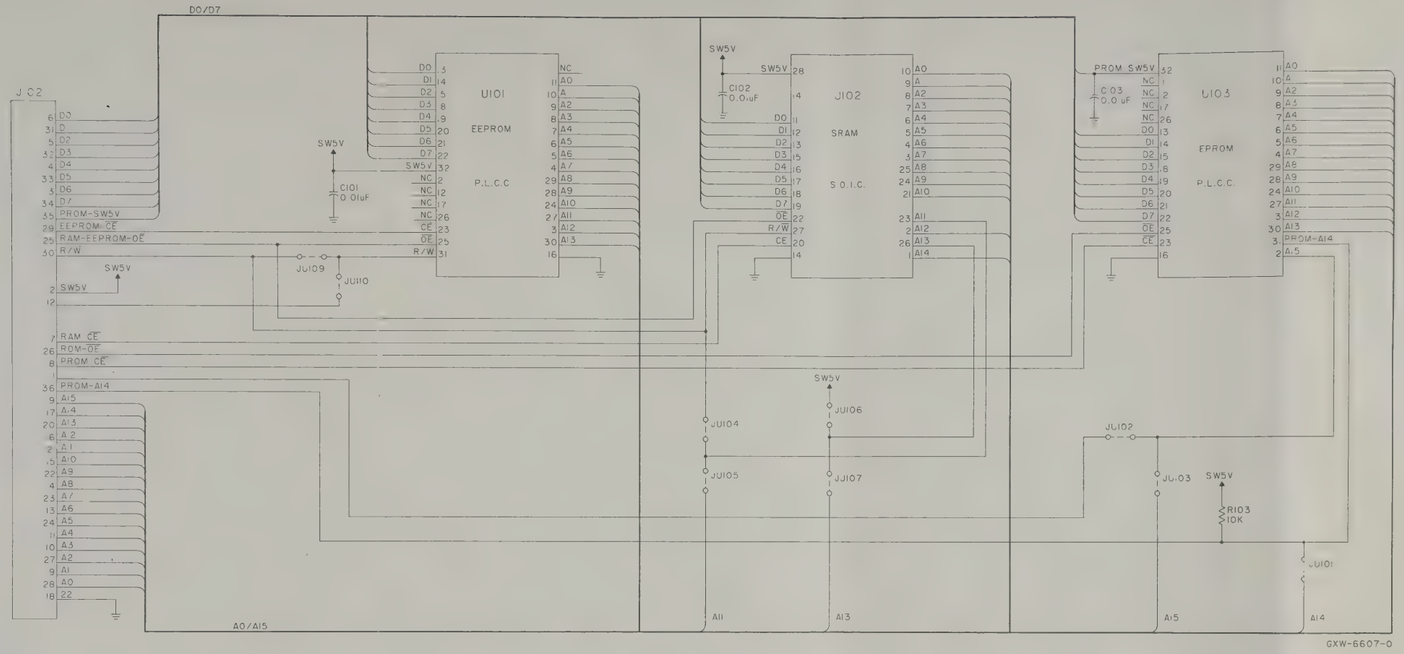
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101–103	21–13741N45	.01
connector		
J101	09–80086M01	socket
jumper		
JU101	06–11077A01	0 ohm
JU103	06–11077A01	0 ohm
JU104	06–11077A01	0 ohm
JU106	06–11077A01	0 ohm
JU109	06–11077A01	0 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R103	06–11077A98	10k
integrated circuit (see note)		
U101	51–907014A11	2k EEPROM (HLN5365C)
	51–907014A10	8k EEPROM (HLN5366C)
U102	51–80049K02	RAM
U103	51–97031A01	32k EPROM
non–referenced parts		
	43–80036M01	standoff, 2 used
	55–80096M01	handle

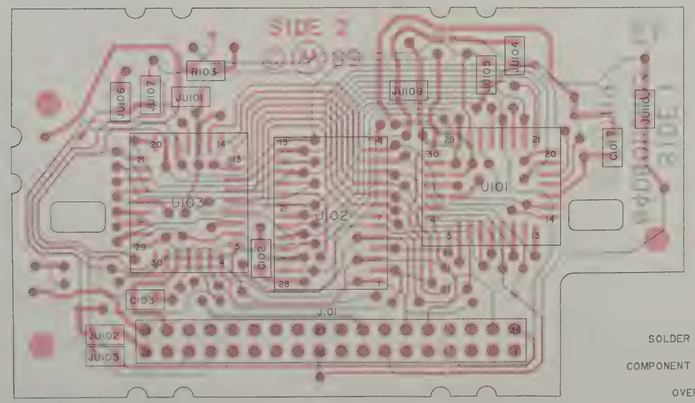
6/30/89

note: For best performance, order diodes, transistors, and intergrated circuit devices by Motorola part number.

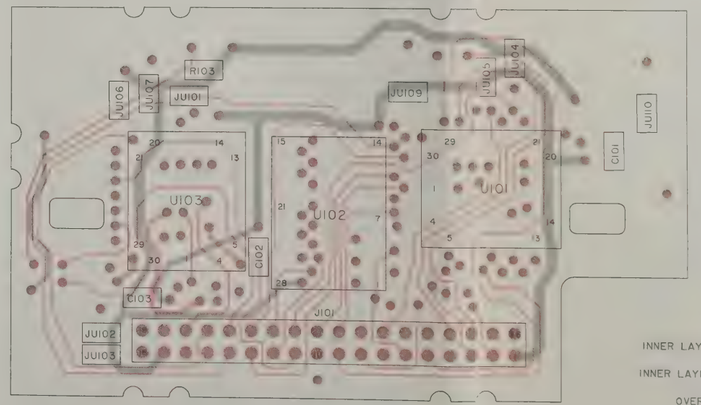
JUMPER TABLE

KIT	JUMPER AND STATUS							
	JU101	JU102	JU103	JU104	JU105	JU106	JU107	JU108
HLN5365C	IN	OUT	IN	IN	OUT	IN	OUT	IN
HLN5366C	IN	OUT	IN	IN	OUT	IN	OUT	IN



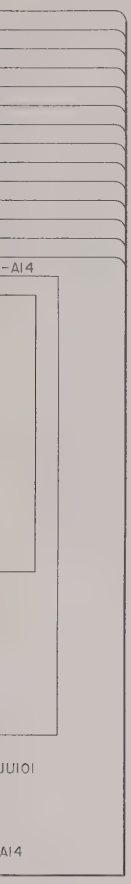


SOLDER SIDE GAW-6603-0
COMPONENT SIDE GAW-6604-0
OVERLAY GXW-6605W01-0



INNER LAYER 1 GAW-6730-0
INNER LAYER 2 GAW-6731-0
OVERLAY GXW-6605W02-0

Schematic, Circuit Board Diagrams, and
Parts List for HLN5365C and HLN5366C
Systems 9000E Trunking Controller Option
PW–6741–O
6/30/89



GXW-6607-0

INNER LAYER 1		GAW-6730-0
INNER LAYER 2		GAW-6731-0
OVERLAY		GXW-6605W02-0

Frequency Synthesizer

1. General

The frequency synthesizer section of the RF board generates the first receive injection frequency and transmitter carrier. In the receive mode, the synthesizer locks on a frequency 53.9 MHz (first IF) below the receive frequency; in the transmit mode, it locks on the transmit output frequency.

The synthesizer uses a phase–locked loop (PLL) to generate frequencies. This PLL operates at half the output frequency and consists of a 14.4–MHz reference oscillator, a low–noise voltage–controlled oscillator (VCO), a high–speed programmable divider, a sample–and–hold phase detector, and a loop adaptive filter. The PLL also uses a buffer doubler/splitter to double the VCO output frequency for the radio. The output of the 14.4–MHz reference oscillator goes via an injection tripler to the second mixer of the receiver, where it serves as the low–side second injection frequency.

The synthesizer circuits are on the common circuits board, RF circuit board, and in the RF internal casting.

2. Theory of Operation

2.1 INTRODUCTION

The PLL is a single negative–feedback loop that uses the phase of the input signals to the phase detector as the controlling variable. The reference divider (part of U608) divides down the frequency output of a high–accuracy, temperature–compensated crystal reference oscillator (U608) to generate a high–stability 6.25 kHz square–wave output that goes to the phase detector (U603–2) to serve as the reference frequency input.

The PLL negative feedback originates at the VCO and goes to the loop frequency input of the phase detector (U603–23). The VCO, a FET RF oscillator (Q652) that operates at approximately 405 MHz, generates an output frequency proportional to the voltage on its steering line (P603–2). A programmable N divider divides this output frequency down until it becomes a loop frequency output equal to the VCO output frequency divided by N, i.e.:

$$f_{(loop)} = F_{(VCO)} / N$$

where: $f_{(loop)}$ = N divider loop frequency output

$f_{(VCO)}$ = VCO output frequency

N = integer

The loop frequency and the reference frequency go to the phase detector (U603–23 and U603–2, respectively), which generates a DC output voltage proportional to the phase difference between them. Phase is used as the controlling variable: small phase errors in the locked loop are permissible, but frequency errors are not. The DC output voltage from the phase detector (PHASE DET OUT at U603–15) goes via the loop adaptive filter to the VCO steering line, thus completing the feedback loop. The loop filter controls the closed loop response of the PLL and removes noise from the phase detector output.

The following describes loop negative feedback action. If the VCO output frequency goes high, the N divider loop frequency output also goes high, causing a leading phase displacement at the phase detector loop input. Since the reference signal phase does not change, the phase detector's internal circuits detect this condition and cause a lower DC voltage to be generated at output U603–14. This signal goes to the VCO steering line via the loop adaptive filter, causes a reduction in frequency, and compensates for the original frequency difference.

2.2 LOOP PROGRAMMING AND CONTROL

For frequency generation and control, the microcomputer reads the programming information from the personality board memory module (code plug in trunked radios), combines it with the synthesizer control information, and multiplexes this information to the programmable divider (U602). The programming information, contained in seven four–bit words, goes to the multiplex programmed divider via four data lines (D0, D1, D2, D3) and three data word address lines (A0,

A1, A2). Address lines A0, A1, and A2 are used in the multiplexing sequence to tell the divider which of the seven four–bit words is being sent by the microcomputer on the data lines.

The bits sent to the divider perform the following functions; One bit, transferred from the divider to the VCO via the BAND SHIFT line (P650–5), determines the band of VCO operation. Sixteen bits program the "A" and "B" counters inside the programmable divider. Two bits program a reference divider. Two latched bits ($\overline{C0}$ and $\overline{C1}$) go from the multiplex programmed divider to the programmable variable–modulus prescaler (U602–15 and U602–16, respectively) to control its operation during the divide cycle. Two other latched outputs from the divider, $\overline{S0}$ and $\overline{S1}$, are used by the sample–and–hold phase detector to control the loop adaptive filter. When set high, $\overline{S1}$ indicates a change in frequency. In this case, a seventh word is generated to clear the frequency change indication by setting $\overline{S1}$ low, thus generating a control pulse. $\overline{S0}$ switches between the transmit and receive loop filters (high for transmit filter).

The seven four–bit words on the data lines remain the same once the condition of synthesizer operation and the frequency have been selected. any change in radio mode causes the microcomputer to address different memory locations in the memory module (code plug in trunked radios). Consequently, the seven four–bit words may supply different information to the divider via the data lines. The microcomputer notifies the divider, via the STROBE line, when the binary information on the data and address lines can be read into the divider and latched in without any chance of error.

2.3 DIVIDER

The programmable N divider uses a method of frequency division known as a "dual–modulus prescaling." It has two dual–modulus prescalers: a divide–by–3–or–4 prescaler (with its own internal programmable "C" counter), and a divide–by–63–or–64 prescaler. The divide–by–63–or–64 prescaler, with its two programmable counters "A" and "B," is in divider U602. The output frequency of each of the two prescalers is first divided by one divisor to yield a fixed number of counts, then divided by a second divisor to yield a different number of counts. The total division system can be set to an integral value N by the programming of counters "A," "B," and "C." This system allows the basic division of programmable divider U602 to be expanded to a higher operating frequency without loss of resolution.

For each PLL output frequency, a different value of N must be programmed into the programmable counters. On the positive–going loop pulse edge, the divide–by–3–or–4 prescaler starts dividing by four and continues to do so until the "C" counter reaches zero. At this time, the prescaler enters into the divide–by–3 mode. Once the loop pulse goes low, the "C" counter is preset to the value determined by the $\overline{C0}$ and $\overline{C1}$ bits. This causes a new cycle to begin on the positive–going edge of the next loop pulse.

The divide–by–63–or–64 variable–modulus prescaler works in a similar fashion. When a loop count begins, it initially divides by 64 for the number of times programmed into the "A" counter. When the "A" counter counts to zero, the loop pulse goes low and the prescaler changes to the divide–by–63 mode. It stays in this mode until the "B" counter reaches zero. At this time the loop pulse goes high and the cycle repeats.

Another programmable divider acts on the 14.4–MHz reference oscillator input frequency at U602–2 to generate one of three reference frequencies: 4.166 kHz, 5.00 kHz, or 6.25 kHz (6.25 kHz in all 800–MHz radios). One word of the frequency select data contains two bits (D0 and D1) that select one of these reference frequencies, as shown in Table 1.

Table 1. Reference Frequency Selection

D0	D1	REFERENCE FREQUENCY
0	0	UNUSED
0	1	4.16 kHz
1	0	6.25 kHz
1	1	5.00 kHz

The frequency select data also contains bits VCO1 and VCO2. VCO2 selects the VCO band shift window required by the selected operating frequency. See the VCO paragraph for details on the band shift windows.

When the VCO bit is latched into the divider, VCO2 is forwarded from U602–20, via Q600, as a BAND SHIFT signal (not used in trunked radios). It is then routed via the feedthrough plate to the VCO. An NPN transistor in U600 compensates for the different modulation characteristics of the VCO windows. When the BAND SHIFT signal is high, the transistor turns on, sending a lower–amplitude audio signal to the VCO. The VCO requires less audio input to fully modulate the RF signal when the BAND SHIFT line is high than when it is low. The VCO frequency is shifted upward by approximately 21 MHz (Talkaround only).

2.4 PHASE DETECTOR

Phase detector U603 compares the reference and loop frequency outputs of the divider circuit and generates a DC output signal that controls the VCO frequency. It also monitors the FREQUENCY CHANGE line ($\overline{S1}$) and the LOW BANDWIDTH SELECT line ($\overline{S0}$) and uses this information to generate control signals for the adaptive filter.

The length of time between the positive transition of the reference signal and the positive transition of the loop signal controls the output signal level of the phase detector. When the reference signal goes high (at U603–2), ramp generator Q603 turns on, maintaining a constant current through C630. This constant current generates a linear rise (ramp) in the U603–23) switches to a high level and turns off Q603.

The positive transition of the loop signal, in addition to halting the ramp generator, resets and internal sample timing circuit. The ramp voltage is held constant for a period of time determined by sample timing capacitor C631. During this time, the two hold capacitors (C632 and C633) are charged to a

level determined by the ramp voltage. At the end of the sample time, the ramp capacitor discharges in preparation for the next cycle.

The accumulated charge on the hold capacitors controls the conduction of a push–pull output driver, consisting of an internal NPN transistor and an external PNP transistor controlled by the signal at U603–17. The adaptive filter couples the PHASE DETECTOR OUTPUT signal at U603–15 to the VCO, where it controls the generation of injection frequencies.

The phase detector decodes the FREQUENCY CHANGE signal at U603–5 and the LOW BANDWIDTH SELECT signal at U603–3 to generate four control signals that are coupled to the adaptive filter. These four control signals are: ADAPT, $\overline{\text{ADAPT}}$, RSW, AND TSW (appearing at U603–10, –7, –9, and –8, respectively).

When the operating channel changes with the radio in the receive mode or the radio changes from the transmit mode to the receive mode, the FREQUENCY CHANGE pulse at U603–5 causes the ADAPT line to go high and the ADAPT line to go low. Since the LOW BANDWIDTH SELECT line is low, the RSW line is driven high, the TSW is driven low, and the adaptive filter is forced into the receive–adapt mode. The $\overline{\text{ADAPT}}$ line returns to a high level and the ADAPT line returns to a low level after approximately 2.4 milliseconds, under the phase detector control, forcing the adaptive filter to enter into the normal receive mode.

When the PTT pushbutton is pressed, the FREQUENCY CHANGE pulse causes the ADAPT line to go high and the $\overline{\text{ADAPT}}$ line to go low. Since the LOW BANDWIDTH SELECT line is high, the TSW line is driven high, the RSW is driven low, and the adaptive filter is forced into the transmit–adapt mode. The ADAPT and $\overline{\text{ADAPT}}$ lines switch states after approximately 12 milliseconds, under control of the phase detector, and the adaptive filter is forced to enter into the normal transmit mode.

While the ADAPT line is high during the transmit–adapt mode, the power amplifier is disabled. (This line is connected to the personality board via J602–11.) Moreover, the ADAPT line is forced to switch to a high state when the synthesizer cannot achieve lock, thus preventing the radio from transmitting unstable or off–frequency signals.

For maximum switching speed, the microcomputer sends new data to the synthesizer at the appropriate time of the divide cycle. The phase detector sends a SYNTHESIZER SYNC signal from U603–4 to the microcomputer via J602–9, to notify the microcomputer of the appropriate time to send new frequency programming information.

2.5 ADAPTIVE FILTER

2.5.1 General

The adaptive filter is a low–pass filter in the steering line between the phase detector and the VCO. This filter removes noise and variations in the steering line level to prevent unwanted modulation of the VCO.

The adaptive filter, which is connected to PHASE DETECTOR OUTPUT line U603–15, is controlled by the phase detector to operate in one of four selectable modes, depending upon the state of the synthesizer at any time. Each mode requires different filter characteristics, and these characteristics are selected by transmission gates that switch the filter components into and out of the steering line signal path, as required.

2.5.2 Filter Mode Selection

The adaptive filter operates in one of four selectable modes: transmit, receive, transmit–adapt, and receive–adapt. Selection of each mode is through a unique combination of states on two complementary pairs of lines: the TSW and RSW lines make up one such pair, and the ADAPT and $\overline{\text{ADAPT}}$ lines make up the other. These coupled lines go from the phase detector to the adaptive filter and connect to the input pins of mode select gates U604A–D. The ADAPT line also connects to transmission gate U607C.

The low–input AND gates (U604A–D) have four output lines: TRANSMIT MODE SELECT, TRANSMIT–ADAPT MODE SELECT, RECEIVE–ADAPT MODE SELECT, and RECEIVE MODE SELECT, respectively. For each filter operation mode selected, one of these output lines is switched into a high state (between +8.6 and +9.6 V). Because these gates use low–level inputs, the output of a gate goes high whenever both of its inputs go low, as follows:

- The TRANSMIT MODE SELECT line (U604A–3) is high when both the ADAPT signal (U604A–1) and RSW signal (U604A–2) are low.

- The TRANSMIT–ADAPT MODE SELECT line (U604B–4) is high when both the RSW signal (U604B–5) and $\overline{\text{ADAPT}}$ signal (U604B–6) are low.

- The RECEIVE MODE SELECT line (U604D–11) is high when both the TSW signal (604D–12) and ADAPT signal (U604D–13) are low.

- The RECEIVE–ADAPT MODE SELECT line (U604C–10) is high when both the $\overline{\text{ADAPT}}$ signal (U604C–8) and TSW signal (U604C–9) are low.

The output lines of the select gates (U604A–D) connect to transmission gates U605A–D, U606A–D, and U607B–C. Gates U607A and U607D are not used. When a select gate output goes to a high level, the associated transmission gates turn on, passing the signals as through a closed switch. Transmission gates U605A–D and U606A–D have ON impedances of less than 200 ohms. Transmission gates U607B–C have ON impedances of less than 500 ohms.

2.5.3 Transmit Mode

When the synthesizer is in the normal transmit mode, the phase detector drives the TSW and $\overline{\text{ADAPT}}$ lines high and their complements, RSW and ADAPT, low. The output of gate

U604A goes high, turning on transmission gates U606A and U606B. The natural loop frequency of the synthesizer in this mode is approximately 15 Hz. The adaptive filter stays in this mode during radio transmissions.

In this mode, resistor R633 and a shunt path to ground consisting of C638, C639, C672, and R634 filters the steering line. The ON impedance of the transmission gates is neglected. Another shunt path to ground, R635, R636, C640, and C641, connects to the phase detector output but has minimal effect because of the high resistance of R635 (33 kilohms). The signal passes to the VCO via jumper JU600 and J650–2.

2.5.4 Receive Mode

When the synthesizer is in the receive mode, the phase detector drives the RSW and $\overline{\text{ADAPT}}$ lines high, and their complements, TSW and ADAPT, low. The output of gate U604D goes high, turning on transmission gate U607B. The natural loop frequency of the synthesizer in this mode is approximately 75 Hz. The adaptive filter remains in this mode while the radio is in the receive mode.

In this mode, R635 and a shunt path consisting of R636, C640, and C641, and R631, and C672 filters the steering line. The ON impedance of the transmission gates is neglected. The signal passes to the VCO via jumper JU600 and connector J650–2.

2.5.5 Transmit–Adapt Mode

When the synthesizer is in the transmit–adapt mode, the phase detector drives the TSW and ADAPT lines high and drives their complements, RSW and $\overline{\text{ADAPT}}$, low. The output of U604B goes high, turning on transmission gates U605A, U605B, and U605D. Transmission gate U607C is turned on directly by the ADAPT line. The synthesizer has a high natural loop frequency in this mode, allowing it to change frequencies rapidly. The adaptive filter is switched into this mode for approximately 12 milliseconds while the radio changes from the receive mode to the transmit mode. The transmitter is inhibited in this mode by the SYNTHESIZER ADAPT line.

In this mode, transmission gate U607C bypasses the greater part of the adaptive filter. A grounded capacitor, C639, connects to the steering line. The ON impedance of the transmission gates is neglected. While the filter is in this mode, C639 and C672 are being charged. The charge on C672 prevents the VCO from changing frequency during the transition from the transmit–adapt mode to the transmit mode. C672 always remains connected to the steering line. The steering line is connected to the VCO via jumper JU600 and J650–2.

2.5.6 Receive–Adapt Mode

When the synthesizer is in the receive–adapt mode, the phase detector drives the RSW and ADAPT lines high and their complements, TSW and $\overline{\text{ADAPT}}$, low. Output gate U604C goes high, turning on transmission gates U605C, U606C, and U606D, and the ADAPT line turns on transmission gate U607A directly. The synthesizer has a high natural loop frequency in this mode, allowing it to change injection frequencies rapidly. The adaptive filter switches into the mode for approximately 2.4 milliseconds while the radio changes from the transmit mode to the receive mode or from one receive frequency to another (as when changing the operating channel of the radio).

In this mode, the greater part of the adaptive filter is shorted by transmission gate U607A, and the steering line is connected to C641. The ON impedance of the transmission gates is neglected. When the filter is in the receive–adapt mode, C641 and C672 are being charged. The accumulated charge on C672 prevents the VCO from changing frequencies during the transition from the receive–adapt mode to the receive mode. C672 always remains connected to the steering line. The steering line is connected to the VCO via jumper JU600 and J650–2.

When the frequency changes (or if for any reason the loop falls out of lock), the phase detector switches the adaptive filter to the ADAPT mode. Consequently, the $\overline{\text{ADAPT}}$ line switches to a low state, turning on the OUT–OF–LOCK indicator LED. Therefore, in normal operation of the frequency synthesizer, the OUT–OF–LOCK indicator LED turns on briefly whenever the frequency changes.

During *Channel Scan* operation (not applicable in trunked radios), the radio can be changing frequencies repeatedly at a fast rate, causing the OUT–OF–LOCK indicator LED to light dimly. On the other hand, a strongly lit indicator LED points to the presence of an out–of–lock fault in the frequency synthesizer. Therefore, this indicator LED is useful for troubleshooting.

In non–trunked radios, various radio functions deactivate each time the frequency synthesizer goes into the ADAPT mode. First, the high ADAPT output disables the radio's audio stages via the squelch circuits on the common circuits board. The transmitter and IDC circuits are disabled via the personality board, a fail–safe feature that prevents transmitter key–up (in the unlikely event that a loss–of–lock malfunction occurs), and prevents the generation and transmission of uncontrolled RF signals.

2.5.7 Super Filter

Because the VCO requires a very pure DC supply voltage, it receives a very–low–noise +8.6 volts from an ultra–low–pass filter (U600). This filter removes any ripple or noise present from the +9.6 V supply line, preventing the unwanted modulation of the VCO. It also lowers the voltage by one volt.

The super filter consists of a low–pass filter, an error amplifier, and an external series–pass transistor (Q601). The +9.6 V supply connects to U600–1 as well as to the emitter of Q601. Internally, the input from U607–1 passes through a low–pass filter to the non–inverting input of the error amplifier. C603, connected to U607–2, forms part of the low–pass filter. The output line (also connected to the collector of Q601) is fed back to the inverting input of the error amplifier through U607–4. The error amplifier output,

connected to the base of Q601 via U600–3, controls the conduction of the transistor.

The super filter compares the output line voltage with the filtered input line voltage and increases or decreases the conduction of Q601 to remove any ripple or noise from the VCO supply line. The VCO supply is further filtered by C604, which connects to ground. This filtered supply then goes to the VCO through the VCO interconnect plate via J650–1. The +9.6 V supply also goes to the buffer doubler through the VCO interconnect plate via J650–6.

2.5.8 Feedback Buffer

A signal at oscillator frequency is fed back from the buffer doubler/splitter to the RF board. The divider/phase detector circuits use this signal to monitor the oscillator frequency.

The feedback buffer, Q602, accepts an input signal from a microstrip pickup on the buffer doubler substrate via a coaxial cable and connector P/J600. The feedback amplifier output is coupled to divide–by–3–or–4 prescaler U601 via a matching network consisting of L601 and C67.

2.6 VOLTAGE–CONTROLLED OSCILLATOR (VCO)

2.6.1 General

The radio uses a voltage–controlled oscillator (VCO) and a buffer/doubler amplifier to generate frequency–modulated (FM) transmit injection frequencies and receive injection frequencies. Standard and trunked radios use a VCO that also has a band switch circuit.

After doubling, the VCO frequency range extends from 53.9 MHz below the lowest receiver operating frequency (797.1 MHz to 816.1 MHz) to the highest transmitter frequency (806 MHz to 825 MHz). In radios with the Talkaround option, a PIN diode switch, CR650, extends the transmit frequency range to 851 to 870 MHz. The VCO and buffer doubler/splitter also supply a feedback signal whose frequency is one–half of the injection frequency for use by the phase–locked–loop synthesizer.

Both VCO and buffer kits are constructed on an alumina thick–film microstrip substrate. Both circuits are similar, but the Talkaround VCO includes the PIN diode switching circuitry.

2.6.2 Oscillator Circuit

The oscillator has a grounded–gate Colpitts circuit with a FET (Q652) for the amplifying element. The oscillator operates at one–half the injection frequency: 398.55 to 412.5 MHz for standard and trunked radios; 298.55 to 433 MHz for Talkaround–equipped radios. The drain of Q652 is coupled to the main resonator transmission line through C660.The transmission line has microstrip capacitors that act as trimming capacitors for the oscillator tank circuit. These factory–adjusted capacitors are independent of the customer's frequencies.

The oscillator supplies an output signal that is coupled to amplifier Q651 on the VCO substrate. Q651, in turn, sends an output signal to the buffer doubler amplifier (Q675, Q676, Q678), which is in a compartment adjacent to the VCO. The buffer doubler amplifier puts out three signals: (1) a signal at one–half the injection frequency that is coupled, via P600, to the RF board to drive the prescaler and send feedback to the phase–locked–loop synthesizer; (2) a signal that is coupled to the transmitter via P700; and (3) a signal that is used to the receiver injection filter via P101.

2.6.3 Steering Line Circuit

The STEERING line, in conjunction with the BAND SHIFT line (when used), determines the VCO operating frequency. Phase detector U603 drive the steering line and couples to the VCO via the adaptive filter. The phase detector supplies a DC output voltage to maintain the VCO output on frequency. When the oscillator frequency is changed, the phase detector DC output voltage shifts to change the oscillator frequency and then maintain this new frequency. Figure 1 shows the injection frequency as a function of the STEERING line DC voltage for two parameters (Talkaround–equipped radios): PIN diode on and PIN diode off.

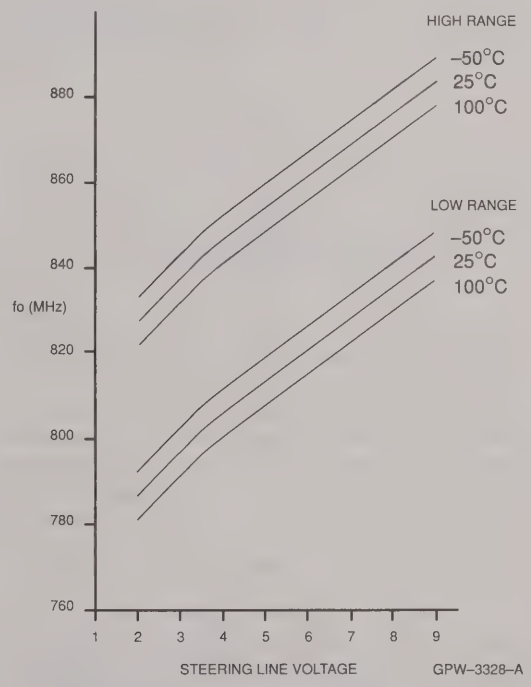


Figure 1. Injection Frequency vs. DC Voltage

The STEERING line is coupled from the RF board via J650–2 and the VCO interconnect plate. The plate contains RF filters that shield the VCO. The STEERING line DC voltage level determines the capacitance of varactor diodes CR652, CR653, CR654, and CR655, and this in turn controls the oscillator frequency. An increase in the STEERING line voltage lowers the capacitance of these diodes and raises the oscillator frequency. On the other hand, a decrease in the

STEERING line voltage increases the capacitance of the diodes and reduces the oscillator frequency.

2.6.4 Modulation Line

Both VCO and buffer kits are directly modulated by the transmit audio signals through a second varactor diode circuit that employs CR651 and CR657. J650–4 and the VCO interconnect plate couple the transmit audio signal to CR651, which modulates the oscillator frequency. CR657 maintains the modulation level constant throughout the radio operating frequency range.

2.6.5 Optional PIN Diode Shift Circuit

An optional PIN diode circuit allows the VCO to cover the direct mobile–to–mobile frequencies or Talkaround range of 851 MHz to 970 MHz. This PIN diode adds another transmission line resonator in parallel with the main resonator line. The circuit is controlled by the BAND SHIFT line, which is coupled from the RF board via J650–5 and the VCO interconnect plate.

When the BAND SHIFT line goes low, CR650 becomes forward–biased, causing the BAND SHIFT line to be connected, via C654, in parallel with the main resonator. This reduces the inductive portion of the oscillator tank circuit and increases the oscillation frequency.

2.7 TRANSMIT AUDIO CIRCUITS

Note

See the IDC portion of the Common Circuits Board Schematic, behind the Common Circuits Board tab of this manual.

The transmit audio circuits consist of four stages (U502A–D) that condition the microphone audio signal for direct frequency modulation of the transmit injection signal. The greater part of the audio path is controlled by the IDC ENABLE signal that is coupled to the IDC (instantaneous deviation control) circuitry via P401–6. This signal controls transmission gate U501A, which enables the transmit audio circuits only when the radio is in the transmit mode. The feature prevents any noise present in the audio circuitry from modulating the receive injection signal.

The MIC HI signal is coupled into pre–emphasis amplifier U502D via P401–5. This amplifier has a frequency response that strengthens the audio frequencies toward the high end of the transmit audio frequency range (approximately 300–3000 Hz). The amplifier output (at U502–12) is coupled to U501–1. When PTT is activated, the transmission gate control line (at U501–13) switches to a high level and the signal passes through the gate to limiter/amplifer U502A.

The limiter/amplifier clips the audio signals at 7 volts peak–to–peak, thus preventing excessive audio modulation of the transmitted signal. (With lower audio input levels, this amplifier acts as a linear gain stage). The limited transmit audio signal is coupled from U502–3 to splatter filter stage U502C.

The splatter filter is a 3–kHz low–pass filter that removes higher–order harmonics from the audio signal. With unity gain, this filter attenuates high–frequency harmonics present on the clipped audio signal from the limiter stage. The splatter filter output passes from U502–10 to the combiner stage via the resistors that form part of HY502.

The audio combiner (U502B and part of hybrid HY502) serves to combine two sources of external modulation, such as PL or DPL (or TX data in trunked radios), along with the audio signal from the splatter filter. Transmission gates U501B and U501C are connected in series with the external modulation inputs, so that these can be disabled when necessary. Normally, these enable lines are pulled high by the HY501 resistors.

The output of the audio combiner is coupled to the deviation adjust potentiometer, R517. The compensation adjust potentiometer, R516, receives a signal from the wiper of R517. A portion of the combined audio signal frequency–modulates the reference oscillator, thus preventing the phase detector output from defeating the direct low–frequency modulation of the VCO generated by the PL/DPL (or TX data in trunked radios) signal. (The reference oscillator and phase detector are shown on the synthesizer schematic diagram.) The compensation adjust potentiometer, R516, is adjusted at the factory and should be readjusted only if the common circuits board, reference oscillator, or VCO is changed. To adjust R516, follow the procedure in the Radio Alignment and Adjustments part of the Maintenance and Troubleshooting section of this manual.

Reference modulation inhibit switch Q502 is allowed to conduct while the radio is in the receive mode, shorting the reference modulation signal line to ground. This prevents any noise induced on the line in the receive mode from affecting the reference oscillator and, consequently, the receive injection frequency. During initial turn–on, C508 is charged through Q502. This allows a stage receive frequency to be attained almost immediately. Q502 is turned off by keyed 9.4 V during transmit, enabling the reference modulation signal line.

3. Synthesizer Troubleshooting Procedure

3.1 GENERAL

The synthesizer troubleshooting chart, farther on in this manual, sets forth a comprehensive procedure for troubleshooting the frequency synthesizer.

The major problems that may occur in the frequency synthesizer are:

- Synthesizer does not lock,
- Synthesizer locks on wrong frequency,
- Excessive reference frequency feedthrough (spurs),

- Noisy frequency lock,
- Slow switching response.

Table 2 summarizes the problems in a frequency synthesizer and their possible causes. Tables 3 through 6 are also useful for troubleshooting, showing pin connections and voltages for the phase detector, divider, prescaler, and super filter.

The troubleshooting chart for the frequency synthesizer mentions an open–loop test and checking the divider programming. There are no flowcharts for these two procedures, but the following paragraphs describe them.

3.2 OPEN–LOOP TEST

3.2.1 Introduction

This test calls for the use of a variable power supply, a frequency counter, a dual–trace oscilloscope, a DC voltmeter, and an RF voltmeter. The Maintenance and Troubleshooting section of this manual lists recommended makes and models of this equipment.

The open–loop test consists of four procedures:

- VCO frequency test,
- Loop and reference waveforms check,
- Phase detector check,
- Adaptive filter check.

3.2.2 VCO Frequency Test

(1) Remove jumper JU600 to open the STEERING LINE loop. Connect a one–kilohm resistor to the plus terminal of a 0 – 10 V adjustable power supply and connect the free end of the resistor to the VCO side (at the point from which JU600 was removed, i.e., the side not connected to C637). Connect the negative terminal to A–. This power supply serves as a steering line in this test.

(2) Connect a frequency counter to the transmitter output port of the RF internal casting (P700). While monitoring the VCO output frequency, slowly change the steering line voltage from 2.5 V to 9.0 V. Verify that the proper synthesizer output frequency appears at some voltage in this range. If it does not, check the BAND SHIFT bit to the VCO at J650–5 and verify that it is in the proper state: low (approximately 0.2 V) for 850 – 870 MHz or high (approximately 8 V) for 797 – 820 MHz. If this signal is correct, the VCO is faulty and should be replaced. (See the radio disassembly procedure in the Maintenance and Troubleshooting section of this manual.) Also check the output level at the VCO divider port (P/J600) and verify that it is between 0 and 8 dBm for the specified steering line voltage range (1.0 V to 9.6 V).

3.2.3 Loop and Reference Waveform Check

(1) Connect one channel of a dual–trace oscilloscope to U602–5 (REF OUT) and the other to U602–9 (LOOP OUT). Adjust the oscilloscope to trigger on the REFERENCE waveform. The oscilloscope trace should be in the chopped mode.

(2) Observe the LOOP waveform and verify that it moves smoothly across the screen without any jitter when the steering line is varied from 1.0 V to 9.6 V.

(3) Observe the REFERENCE signal and verify that its period is 160 microseconds without any jitter, and that one steering line voltage from 2.5 to 9.0 V does not exactly yield this period on the loop divider output.

(4) If the conditions specified in Steps 2 and 3 are met, then check the divider buffer (Q602 and associated components), the prescaler (U601), the divider (U602), the reference oscillator (U608), and the divider programming. Check the prescaler by capacitively coupling a 200–MHz frequency counter to its output and verifying that the output is approximately one–third of the input frequency (or one–sixth the desired loop output frequency). It will not be exactly one–third because the prescaler is dividing by four part of the time. The difference should not exceed 50 ppm.

3.2.4 Phase Detector Check

Check the phase detector (U603) by adjusting the steering line voltage for a loop period slightly longer than the reference period and then for a slightly shorter period. With a longer loop period, the phase detector output (U603–15) should switch to a high state (greater than 9 V); with a shorter loop period, the phase detector output should switch to a low state (1.2 V). If this does not happen, check the phase detector and associated circuitry.

3.2.5 Adaptive Filter Check

Check the adaptive filter for short or open circuits by removing jumper JU600 and then checking for a high voltage on the adaptive filter side when the base detector output is high. The absence of a high voltage is an indication of a faulty condition.

3.2.6 VCO Steering Line Leakage

Check for VCO steering line leakage by removing jumper JU600 and connecting a one–megohm resistor to the VCO side. Connect the free end of the resistor to an adjustable power supply set to 9.5 V. Use a high–impedance voltmeter (impedance greater than 10 megohms) to measure the voltage drop across the resistor. It should be less than 10 mV. (Be sure to use a shielded cable with the voltmeter when making these measurements.) If the voltage drop is more than 10 mV, either the VCO interconnection plate is leaky or one or more of the VCO steering line varactors (CR652–CR655) are defective. Remove the VCO from the RF internal casting and perform the test again. If the voltage drop is now less than 10 millivolts, replace the interconnection plate. (As before, be sure to use a shielded cable with the voltmeter.)

3.3 DIVIDER PROGRAMMING TEST

The synthesizer troubleshooting chart refers to the divider programming test. For this test, use a dual–trace oscilloscope and a test memory module (TLN2299A). See the list of recommended test equipment in the Maintenance and Troubleshooting section, and Table 4, which lists the pin numbers and functions of the divider (U602). See also the timing diagram on the synthesizer troubleshooting chart, which shows the waveforms generated under Mode 4 of the test memory module.

(1) Connect Channel 1 of a dual–trace oscilloscope to the STROBE line (U602–27) of the divider. Trigger the oscilloscope on the rising edge of the strobe signal.

(2) Connect Channel 2 of the oscilloscope to the A0 line (U602–23) of the divider.

Table 2. Frequency Synthesizer Problems and Possible Causes

PROBLEM	POSSIBLE SOURCE OF TROUBLE
Synthesizer does not lock.	See the Synthesizer Troubleshooting Chart.
Synthesizer locks on wrong frequency. **Note** Frequency errors of 12.5, 25.0, or 27.5 kHz can be caused by a defective prescaler or by shorted or open programming lines from the divider to the prescaler (U601–7, U601–6).	Reference oscillator (U608) frequency off (should be 14.4 MHz +2 ppm).
	Divider programming from microcomputer erroneous (possible defective memory module, or code plug, or microcomputer).
	Divider U602 is defective.
	Prescaler U601 is defective.
Reference frequency feedthrough (spurs) is excessive.	Hold capacitors C632, C633 defective (open or leaky).
	Ramp capacitor C630 defective.
	Phase detector U603 defective.
	Adaptive filter in ADAPTIVE mode or shorted input to output ; guard band shorted to VCO steering line or other adaptive filter mode.
Frequency lock is noisy.	Input level to prescaler (U601–1), loop divider (U602–25), or reference divider (U602–2) is marginal.
	Loose connection, cold solder joint, or faulty component.
	Noisy Q603.
	Phase detector U603 defective.
	Defective divider U602 or prescaler U601 (jittery).
	Defective adaptive filter (open capacitors).
Switching response is slow.	Improper synchronization from microcomputer: check divider programming.
	Malfunctioning adaptive filter: check U604, U605, U606, U607.
	Phase detector U603 gain too low (overdamped response) or too high (underdamped response): check R625, R626, RT600, C630, Q603.
	Leaky adaptive filter capacitors or transmission gates (U605, U606, U607, C639, C641).
	Leaky VCO varactor diodes.

Table 3. Phase Detector (U603) Pin Connections and Voltages

PIN	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1	HIGH CURRENT GROUND	—	0V
2	REFERENCE IN	From U602–5	0V to 4.3V square wave (160 us period)
3	LOW BANDWIDTH	From U602–17	0V receive; 5V transmit
4	SYNTHESIZER SYNC	To microcomputer	60 us positive pulse 0 # 5V at loop pulse rate; equal to pin 2 if pin 11 is low
5	FREQUENCY CHANGE	From U602–18	0.5 VS 11.1 uS when frequency changes
6	not connected		
7	ADAPT	To adaptive filter	9.6 to 0.6V single pulse, 2.4 ms (Rx) dekey; 12 ms (Tx) key
8	TSW	To adaptive filter	0V receive, 9.6V transmit
9	RSW	To adaptive filter	9.6V receive, 0V transmit
10	ADAPT	To adaptive filter	0 # 9.0V single pulse, 2.4 ms (Rx) dekey; 12 ms (Tx) key
11	LOCK		0V when out of lock; 8V when in lock
12	HOLD 1	CS11	1.4 to 8V (use high input impedance voltmeter)
13	HOLD 2	CS12	1.4 to 8V (use high input impedance voltmeter)
14	A+		9.6V
15	PHASE DET OUTPUT	To adaptive filter	1.2 to 9.5V (depending on loop output freq.)
16	LOW CURRENT GROUND		0 V
17	EXT PNP BASE	To pnp Q604 base	8.9 V
18	VCC	From regulator	9.6 V
19	RAMP BASE	To pnp Q603 base (ramp generator)	9.1V
20	FILTERED 9.1V	To R624, R625, RT600, C629	9.1V
21	RAMP RES	To R626, pnp Q603	8.0 to 8.7V emitter rectangular wave @ reference rate
22	SAMPLE TIMING CAP.	To C631	0 to 2V sawtooth wave at loop pulse rate
23	LOOP IN PULSE	From U602–9 via C628	1.4V pulse riding on 1.6V (160 us, typical period)
24	RAMP CAP	From C630 and ramp pnp Q603 collector	Flat top ramp waveform at reference rate, top voltage 1.4 to 7V (depending on loop output frequency)

Table 4. Divider (U602) Pin Connections and Voltages

PIN	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1*	GND		0V
2	REFERENCE IN	From U608 (reference oscillator)	1.5V + 0.6V pp AC (14.4 MHz)
3*	3.6 MHz OUT	To microcomputer	1V pp (3.6 MHz)
4	GND		0V
5*	REFERENCE OUT	To U603–2 (phase detector)	0 to 4.3V square wave (5.0 to 6.25 kHz)
6	not connected		
7	not connected		
8	not connected		
9*	LOOP OUT	To phase detector and prescaler	2.9V to 4.3V narrow pulse (1.4V pp) (160 us nominal period)
10*	VCC	From regulator	5V
11	D0	From microcomputer	0 to 5V pulse train
12	D1	From microcomputer	0 to 5V pulse train
13	D2	From microcomputer	0 to 5V pulse train
14	D3	From microcomputer	0 to 5V pulse train
15	C0	To prescaler	0 to 5V
16	C1	To prescaler	0 to 5V
17	LOW BANDWIDTH	To phase detector	0 to 5V
18	FREQ CHANGE	To phase detector	0 to 5V
19	VCO1	No connection	
20	VCO2	To bandshift driver	0 to 0.7V
21	not connected		
22	VBB	To divider	1.5V
23	A0	From microcomputer	0 to 5V pulse train
24	A1	From microcomputer	0 to 5V pulse train
25	PRESCALER IN	From prescaler	1.5V + 0.7V pp AC
26	A2	From microcomputer	0 to 5V pulse train
27*	STROBE	From microcomputer	0 to 5V pulse train (7 pulses/train)

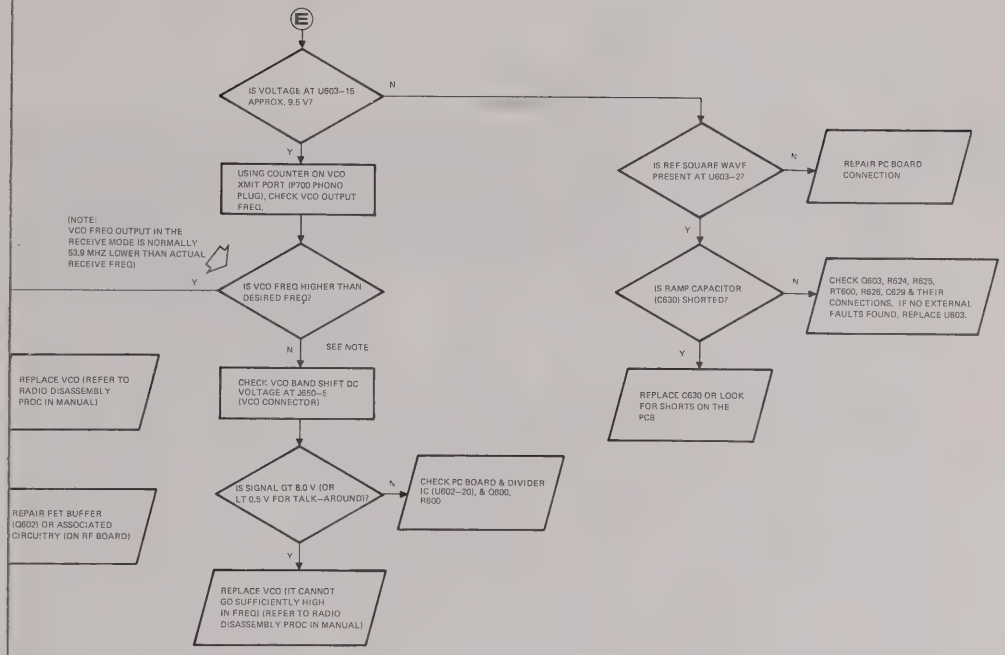
* should be checked first

Table 5. Prescaler (U601) Pin Connections and Voltages

PIN	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1	FIN	From VCO buffer	–12 to 0 dBm (at half carrier or half injection frequency) riding on 3.8V
2	VBB		3.8V, bypassed for RF
3	PRESCALE OUT	To divider (U602)	0 dBm (0.6 V pp) riding on level of 3.6V at approximately 1/3 VCO freqyency (+50ppm)
4	GND		0V
5	FV	From divider (U602)	1.4V p narrow pulse at reference frequency (6.25 kHz) riding on 3.4V
6	$\overline{C1}$	From divider level (programming bit)	0 or 5V; test memory module (4) 0V, mode (5) 5V
7	$\overline{C0}$	From divider level (programming bit)	0 or 5V; test memory module (4) 0V, mode (5) 5V
8	VCC	From regulator	+5.0V +0.1V)

Table 6. Super Filter Pin Connections and Voltages

PIN	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1	VCC	From 9.6V regulator	9.6V
2	FILTER CAP.	C603	7.1V
3	EXT. DRIVER CONTROL	Q601 Base	8.9V
4	8.6V OUT	To VCO	8.6V
5	GROUND (internal NPN emitter)	From regulator	0V
6	INTERNAL NPN COLLECTOR	To modulation compensation potentiometer R602	
7	INTERNAL NPN BASE	From VCO bandshift, R604, R605	0.2V,talkaround transmit; 0.7V, standard transmit, receive
8	NO CONNECTION		



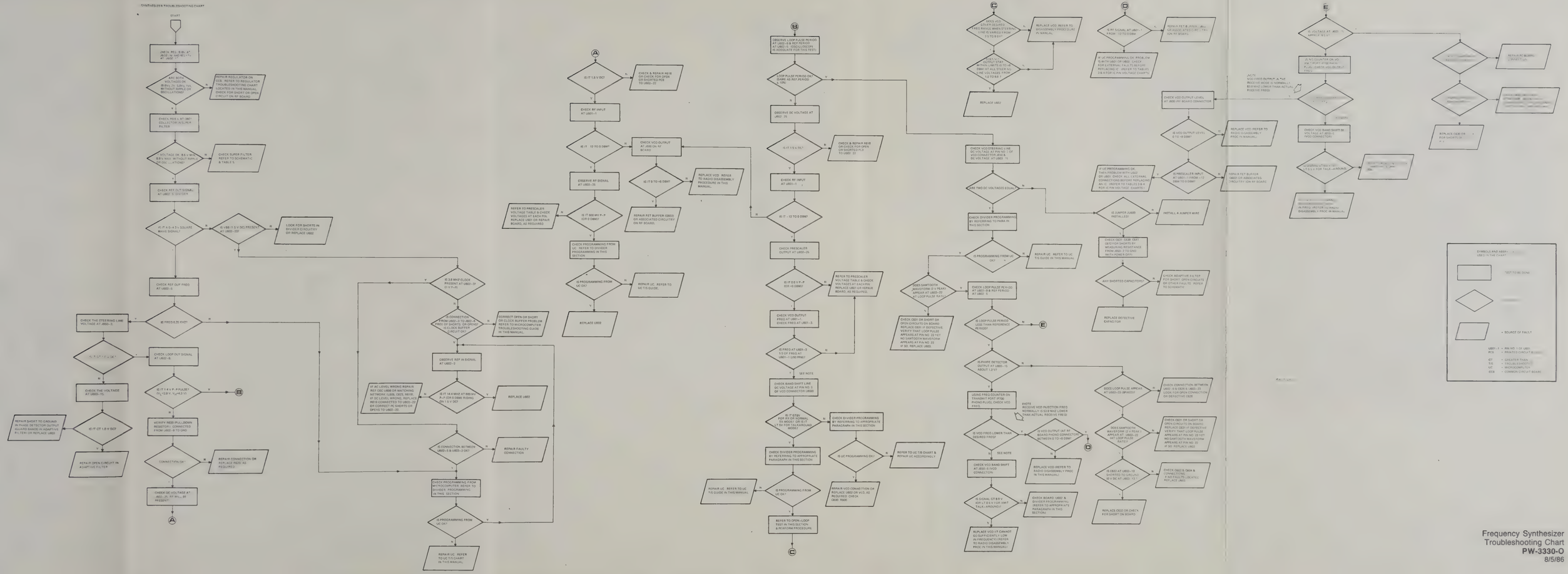
GW-3329-O

SYMBOLS AND ABBREVIATIONS USED IN THE CHART

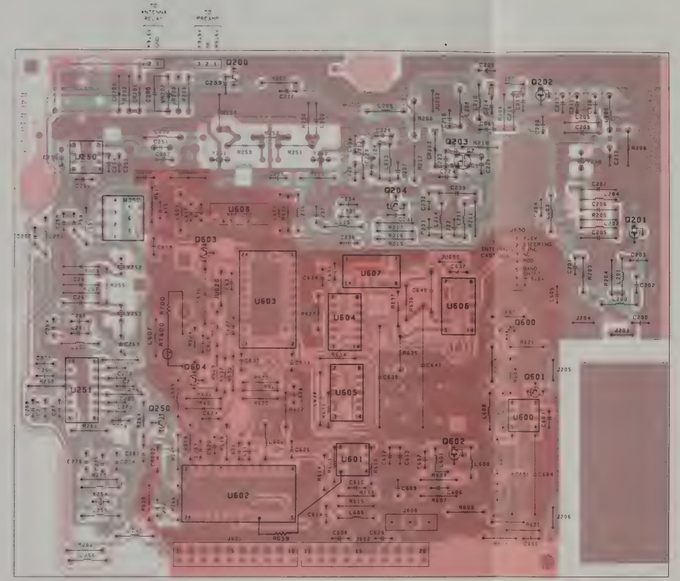
- TEST TO BE DONE
- DECISION
- SOURCE OF FAULT

U601 1 = PIN NO. 1 OF U601
PCB = PRINTED CIRCUIT BOARD
LT = LESS THAN
GT = GREATER THAN
T/S = TROUBLESHOOTING
UC = MICROCOMPUTER
CCB = COMMON CIRCUIT BOARD

Frequency Synthesizer
Troubleshooting Chart
PW-3330-O
8/5/86



Frequency Synthesizer
Troubleshooting Chart
PW-3330-O
8/5/86



SOLDER SIDE ◊ GW-3332-A
COMPONENT SIDE ⊕ GW-3333-A
OVERLAY GW-3334-B

Schematic, Circuit Board Diagrams, and Parts Lists
for RF Board (Frequency Synthesizer Section)
PW-3331-C
(Sheet 1 of 2)
6/30/89

SHOWN FROM SOLDER SIDE

SYNTHESIZER CIRCUITRY

parts list

HRN4000C RF Circuit Board (Synthesizer section) MXW-4595-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 100V (unless otherwise stated)		
C600	23-13749D79	10 ±20%, 25V, tantalum
C601	23-82783B31	47 ±20%, 20V, tantalum
C602	08-11051A07	.01, 63V
C603	23-13749D79	10 ±20%, 25V, tantalum
C604	23-82783B31	47 ±20%, 20V, tantalum
C605-608	21-11014G32	20 pF
C609	08-11051A13	.1, 63V
C610	21-11014H32	20 pF
C611	08-11051A13	.1, 63V
C612	21-11014H32	20 pF
C613,614	21-11015B05	220 pF, ±10%
C615,616	08-11051A07	.01, 63V
C617,618	21-11014H32	20 pF
C619	08-11051A07	.01, 63V
C620	23-13749D79	10, ±20%, 25V, tantalum
C621,622	21-11015B05	220 pF, ±10%
C623	21-11014H29	15 pF
C624	21-11015B05	220 pF, ±10%
C625	08-11051A13	.1, 63V
C626	23-13749D39	.56, ±10%, 50V, tantalum
C627	23-13749D71	4.7, ±20%, 35V, tantalum
C628	21-11015B01	100pF, ±10%
C629	23-84536C06	47, ±20%, 20V, tantalum
C630	08-80027B08	3900
C631	08-11051A06	.0068, 63V
C632	08-11051A05	.0047, 63V
C633	08-11051A01	.001, 63V
C634	08-11051A07	.01, 63V
C635	21-11014H32	20 pF
C637	21-11014H32	20 pF
C638	23-82783B25	1, ±10%, 35V, tantalum
C639	08-80035B04	5, ±10%, 50V
C640	23-84782H20	.27, ±10%, 35V, tantalum
C641	08-83826M01	1, ±10%
diode (see note)		
CR600	48-B2138G01	germanium
CR601	48-B3329G02	silicon
CR602	48-84404E01	LED
connector receptacle		
J600	09-80001F01	phono jack
J601,602	09-83445J09	10 contact
J650	09-83730M01	7 contact
jumper		
JU600	06-11009F23	jumper
JU626	06-11009D23	jumper
coil, RF		
L600	24-83961B01	3 turns, silver–brown
L601	24-83884G06	4.5 turns, white
L602	24-83961B01	3 turns, silver–brown
L603,604	24-82723H45	10 uH, blue–red
L605	24-83397L07	10
L606	24-83961B01	3 turns, silver–brown
L607,608	24-82723H45	10 uH, blue–red
L609	24-82723H28	.29 uH, yellow
transistor (see note)		
Q600	48-00869706	NPN
Q601	48-00869881	PNP
Q602	48-00869839	JFET, N-channel
Q603	48-00869548	PNP
Q604	48-00869643	PNP
thermistor		
RT600	06-80275N01	1k, ±10%
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R600	06-11009C01	10
R601	06-11009C97	100k
R602	06-11009C33	68k
R603	06-11009C65	4.7k
R604	06-11009C89	47k
R605	06-11009G82	24k
R606	06-80036G35	2.7
R607	06-11009C17	47
R608	06-11009C33	220
R609	06-11009C25	100
R611	06-11009C49	1k
R612	06-11009C73	10k
R613,614	06-11009C67	5.6k
R615	06-11009C41	470
R616	06-11009C25	100
R617	06-11009C75	12k
R618	06-11009C49	1k
R619	06-11009C41	470
R620	06-11009C65	4.7k
R621	06-11009C73	10k
R622,623	06-11009C67	5.6k
R624	06-11009C29	150
R625	06-11009C44	820
R627	06-11009C57	2.2k
R628	06-11009C49	1k
R629	06-11009C01	10
R630	06-11009C56	2k
R631	06-11009C67	5.6k

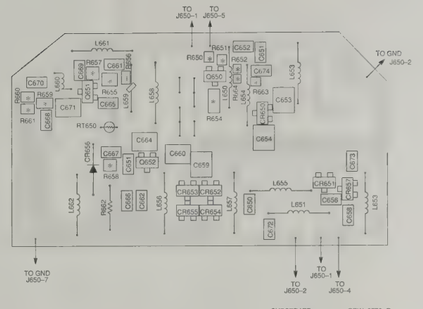
MXW-4595-B (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R632	06-11009C59	2.7k
R633	06-11009D06	220k
R634	06-11009C67	5.6k
R635	06-11009C85	33k
R636	06-11009C61	3.3k
R637	06-11009C57	2.2k
R638	06-11009C53	1.5k
R639	06-11009C87	39k
R700	06-11009C51	1.2k
integrated circuit (see note)		
U600	51-84768F65	low noise filter
U601	51-84768F68	prescaler
U602	51-83977M18	synthesizer
	or 51-84768F63	synthesizer
U603	51-83977M30	phase detector
U604	51-80072C01	2 input NOR gate
U605,606	51-80073C02	bilateral switch
U607	51-80073C03	bilateral switch
U608	51-80291B07	reference oscillator
non-referenced parts		
	75-05295G01	crystal pad base, 6 used
	01-80707T23	shield and strap assembly
	26-83593M01	synthesizer component side shield
	53-84300B02	handle, 2
	37-00132S62	heatshrink tubing
	01-80725T08	handle and shield assembly
	26-83592M01	component side shield
	03-80136F01	metric HI/LO screw
	05-84220B01	nylon snap-in rivet
	26-80055K01	can shield
	26-82270N01	shield
	26-83585M01	synthesizer solder side shield
	26-83586M01	6 pin filter shield
	26-83587M01	detector solder side shield
	26-83588M01	VCO solder side shield
	26-83594M01	component side shield, 6 used
	26-83595M01	detector component side shield
	26-83597M01	prescaler component side shield
	26-83814M01	fence shield
	37-00122D54	tubing
	42-83891L01	mixie clip
	46-83948M01	RF board stud
	75-80193G01	shield pad

7/31/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN5356B VCO



SUBSTRATE GPW-6776-O
OVERLAY GPW-6777-O

* PARTS ARE SCREENED ON RESISTORS

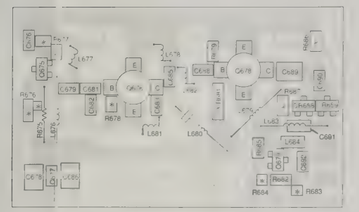
HLN5356B VCO (Talkaround) MXW-3337-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C650-652	21-84873H59	100
C653,654	21-11078B42	100, 100V
C656	21-84873H59	100
C657	21-11078A15	2.7, ±.25 pF, 100V
C658	21-84873H59	100
C659,660	21-11078B13	10, ±.5 pF, 100V
C661–663	21-84873H59	100
C664	21-11078B13	10, ±.5 pF, 100V
C665	21-84078A05	1.5, ±.25 pF
C666	21-84873H63	39
C667–670	21-84873H59	100
C671	21-11078B07	5.6, ±.25 pF, 100V
C672	08-80027B04	.039 uF, 100V
C673	21-11078A09	1.8, ±.25 pF
C674	21-84873H59	100
diode (see note)		
CR650	48-80230E19	common cathode, dual pin
CR651,655	48-82193H55	silicon
CR656	48-84616A11	hot carrier
CR657	48-82190H55	silicon
coil, RF		
L650,651	24-82723H40	290 nH, yellow black
L653–658	24-82723H40	290 nH, yellow black
L659	76-83950B01	ferrite core
L660	24-84331M46	airwound, 7 1/2 turns
L661–663	24-82723H40	290 nH, yellow black
connector		
P603	09-83729M01	7 contact
transistor (see note)		
Q650	48-84939C26	PNP
Q651	48-84411L54	NPN
Q652	48-84939C36	N-channel, FET
thermistor		
RT650	06-83241P03	300
	30-83361Q01	coax cable, 50 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R650–652	—	non–replaceable parts
R654–661	—	non–replaceable parts
R652	06-11041D14	100k

7/24/89

note: For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number.

TRN8871D VCO BUFFER



* PARTS ARE SCREENED ON RESISTORS

SUBSTRATE GPW-6778-O
OVERLAY GPW-6779-O

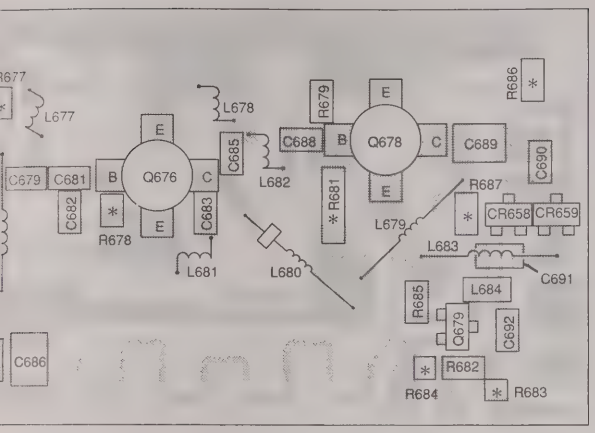
TRN8871D Hybrid VCO Buffer MXW-3338-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21-84873H59	100
C678	21-84547A13	.01 uF, ±10%
C681	21-84873H48	27, ±10%
C682	21-84873H01	3.3, ±.5 pF
C683	21-84873H06	8.2, ±.5 pF
C685	21-84873H63	39
C686	21-84873H44	39
C688	21-84296M05	5, ±.25 pF
C689	21-84873H16	22 pF
C690	21-05157A83	22, ±10%
C691	21-11031A29	39
C692	21-84873H63	39
diode (see note 1)		
CR658,659	48-80013E02	silicon pin
coil, RF		
L676	24-82723H40	290 nH, yellow black
L677	24-80091G08	airwound, 3 turns
L678	24-80091G21	airwound, 4 turns
L679,680	24-82723H40	290 nH, yellow black
L681	24-80091G21	airwound, 4 turns
L682	24-84331M46	airwound, 7 turns
L683	24-82723H40	290 nH, yellow black
L684	24-80140E07	680 nH
plug connector		
P101	28-84228048	male phono
transistor (see note 1)		
Q675	48-84411L54	NPN
Q676	48-84411L66	NPN
Q678	48-80225C08	NPN
Q679	48-80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06-11041D87	8.2k
R676–681	—(note 2)—	non–reparable screened parts
R679	06-11077A56	180
R682	06-11077A36	27
R685	06-11077B06	20k

4/26/88

notes:
1. For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number
2. Resistors are screened directly on substrate, and are not field replaceable

TRN8871D VCO BUFFER



E SCREENED ON RESISTORS

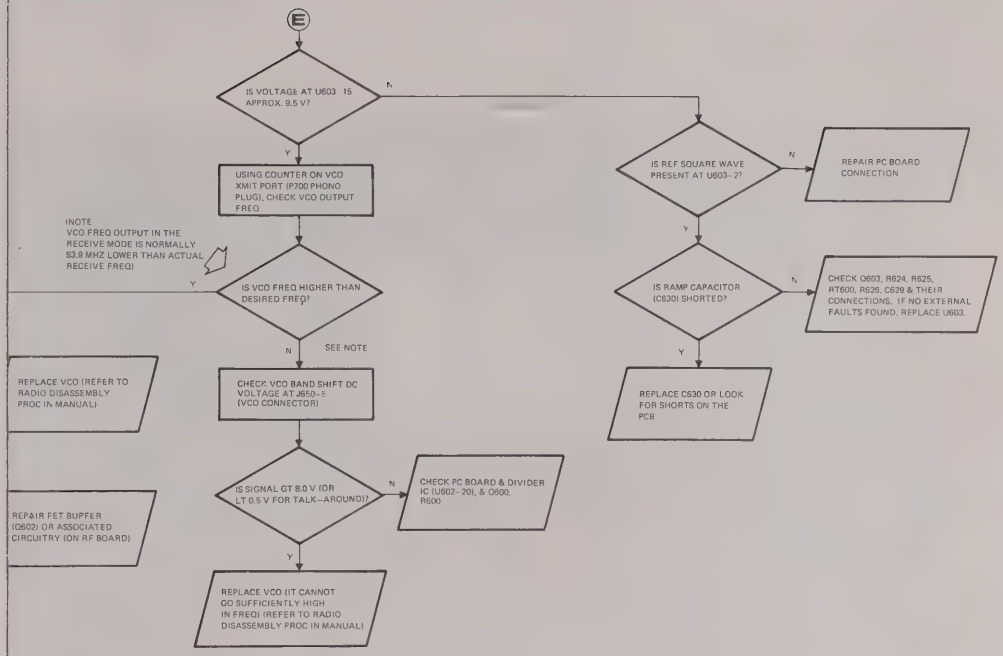
SUBSTRATE GPW–6778–O
OVERLAY GPW–6779–O

TRN8871D Hybrid VCO Buffer MXW–3338–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21–84873H59	100
C678	21–84547A13	.01 uF, ±10%
C681	21–84873H48	27, ±10%
C682	21–84873H01	3.3, ±.5 pF
C683	21–84873H56	8.2, ±.5 pF
C685	21–84873H63	39
C686	21–84873H44	39
C688	21–84296M05	5, ±.25 pF
C689	21–84873H16	22 pF
C690	21–05157A83	22 ±10%
C691	21–11031A29	39
C692	21–84873H63	39
diode (see note 1)		
CR658,659	48–80013E02	silicon pin
coil, RF		
L676	24–82723H40	290 nH, yellow black
L677	24–80091G08	airwound, 3 turns
L678	24–80091G21	airwound, 4 turns
L679,680	24–82723H40	290 nH, yellow black
L681	24–80091G21	airwound, 4 turns
L682	24–84331M46	airwound, 7 turns
L683	24–82723H40	290 nH, yellow black
L684	24–80140E07	680 nH
plug connector		
P101	28–84228048	male phono
transistor (see note 1)		
Q675	48–84411L54	NPN
Q676	48–84411L66	NPN
Q678	48–80225C08	NPN
Q679	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06–11041C87	8.2k
R676–681	—(note 2)—	non–repairable screened parts
R679	06–11077A56	180
R682	06–11077A36	27
R685	06–11077B06	20k

4/26/88

notes:
1. For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number.
2. Resistors are screened directly on substrate, and are not field replaceable.



GW-3329-O

SYMBOLS AND ABBREVIATIONS USED IN THE CHART

TEST TO BE DONE

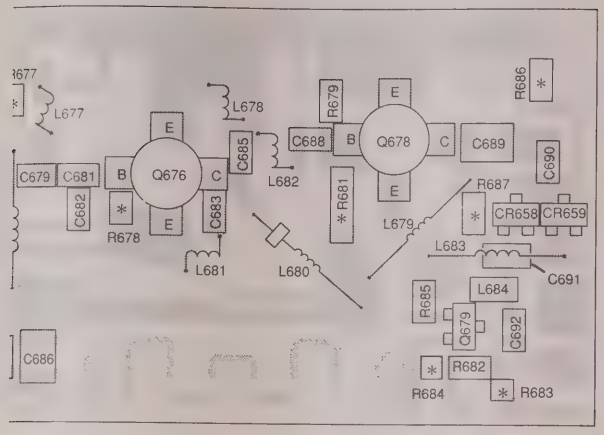
DECISION

* SOURCE OF FAULT

U601 1 - PIN NO. 1 OF U601
PCB - PRINTED CIRCUIT BOARD
LT - LESS THAN
GT - GREATER THAN
T/S - TROUBLESHOOTING
UC - MICROCOMPUTER
CCB - COMMON CIRCUIT BOARD

Frequency Synthesizer
Troubleshooting Chart
PW-3330-O
8/5/86

TRN8871D VCO BUFFER



E SCREENED ON RESISTORS

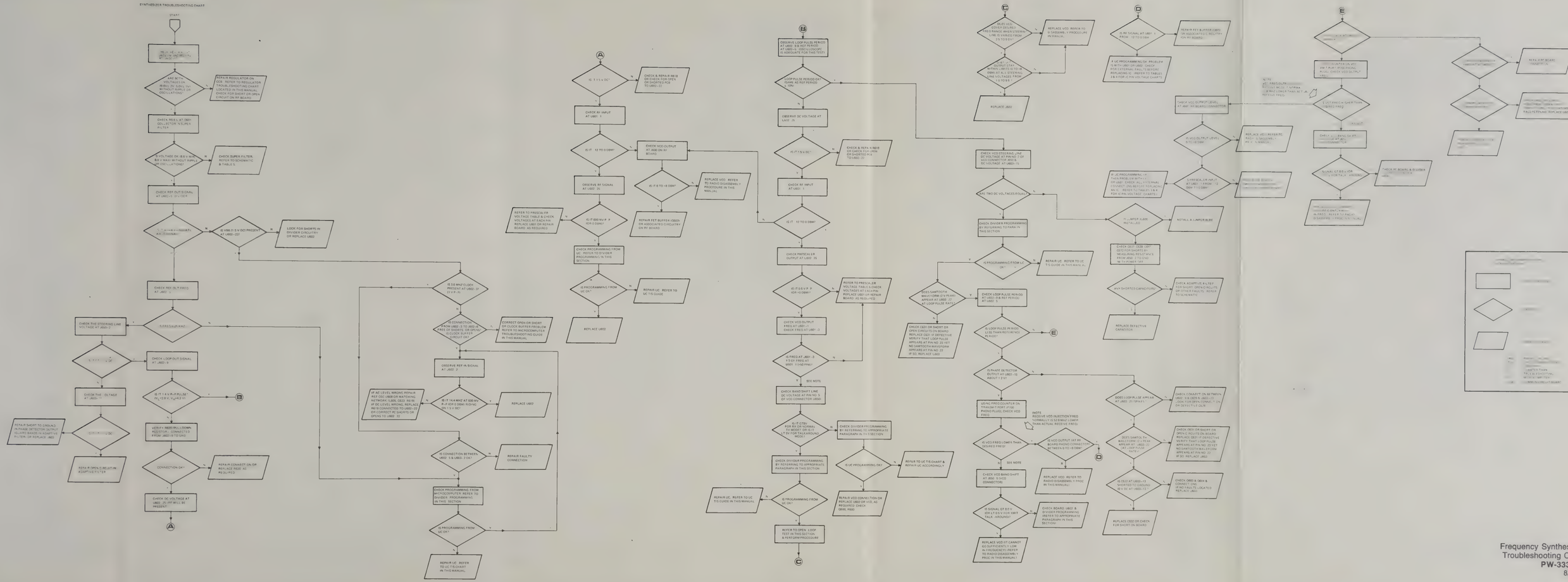
SUBSTRATE GPW–6778–O
OVERLAY — GPW–6779–O

TRN8871D Hybrid VCO Buffer MXW–3338–A

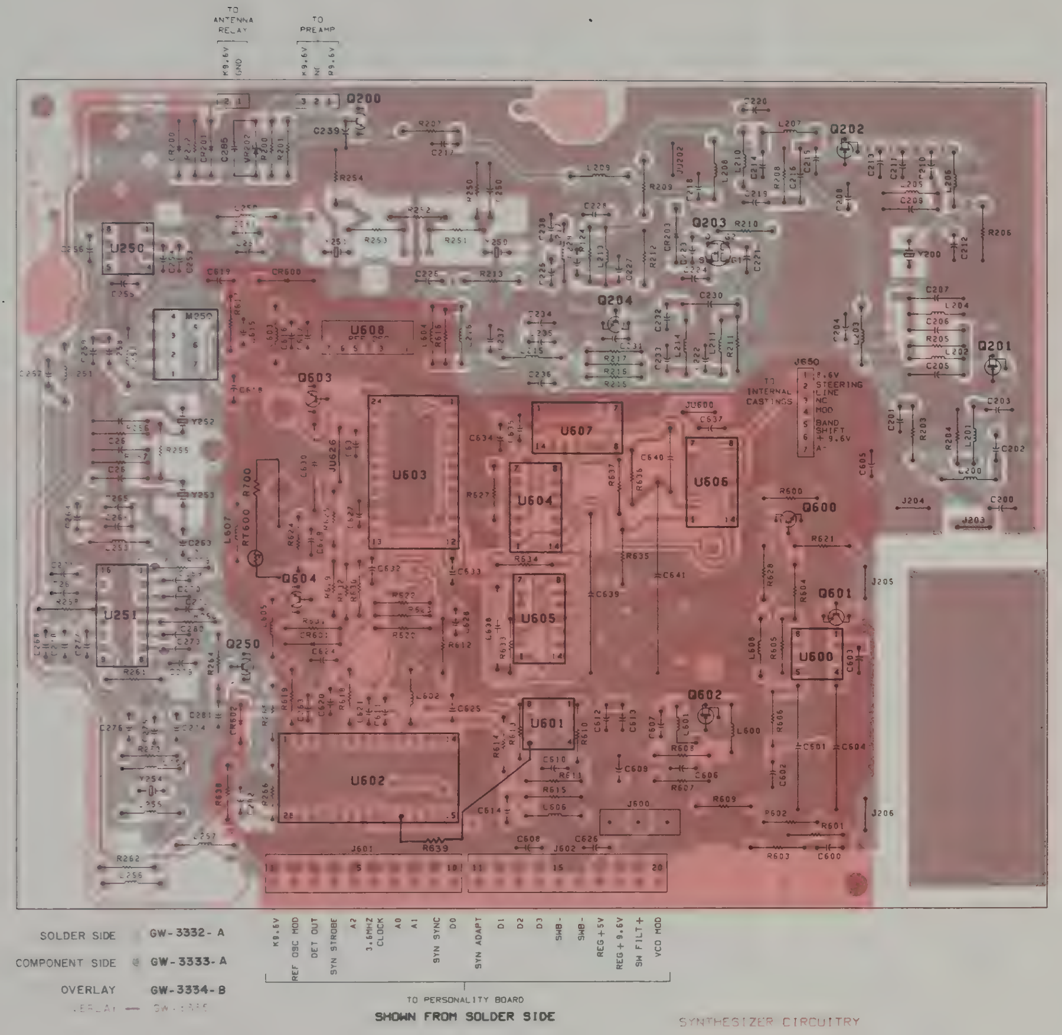
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21–84873H59	100
C678	21–84547A13	.01 uF, ±10%
C681	21–84873H48	27, ±10%
C682	21–84873H01	3.3, ±.5 pF
C683	21–84873H56	8.2, ±.5 pF
C685	21–84873H63	39
C686	21–84873H44	39
C688	21–84296M05	5, ±.25 pF
C689	21–84873H16	22 pF
C690	21–05157A83	22 ±10%
C691	21–11031A29	39
C692	21–84873H63	39
diode (see note 1)		
CR658,659	48–80013E02	silicon pin
coil, RF		
L676	24–82723H40	290 nH, yellow black
L677	24–80091G08	airwound, 3 turns
L678	24–80091G21	airwound, 4 turns
L679,680	24–82723H40	290 nH, yellow black
L681	24–80091G21	airwound, 4 turns
L682	24–84331M46	airwound, 7 turns
L683	24–82723H40	290 nH, yellow black
L684	24–80140E07	680 nH
plug connector		
P101	28–84228048	male phono
transistor (see note 1)		
Q675	48–84411L54	NPN
Q676	48–84411L66	NPN
Q678	48–80225C08	NPN
Q679	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06–11041C87	8.2k
R676–681	—(note 2)—	non–repairable screened parts
R679	06–11077A56	180
R682	06–11077A36	27
R685	06–11077B06	20k

4/26/88

notes:
1. For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number.
2. Resistors are screened directly on substrate, and are not field replaceable.



Frequency Synthesizer
Troubleshooting Chart
PW-3330-O
8/5/86



Schematic, Circuit Board Diagrams, and Parts Lists
for RF Board (Frequency Synthesizer Section)
PW-3331-C
(Sheet 1 of 2)
6/30/89

parts list

HRN4000C RF Circuit Board (Synthesizer section) MXW-4595-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 100V (unless otherwise stated)		
C600	23-13749D79	10 ±20%, 25V, tantalum
C601	23-82783B31	47, ±20%, 20V, tantalum
C602	08-11051A07	.01, 63V
C603	23-13749D79	10, ±20%, 25V, tantalum
C604	23-82783B31	47, ±20%, 20V, tantalum
C605-608	21-11014H32	20 pF
C609	08-11051A13	.1, 63V
C610	21-11014H32	20 pF
C611	08-11051A13	.1, 63V
C612	21-11014H32	20 pF
C613,614	21-11015B05	220 pF, ±10%
C615,616	08-11051A07	.01, 63V
C617,618	21-11014H32	20 pF
C619	08-11051A07	.01, 63V
C620	23-13749D79	10, ±20%, 25V, tantalum
C621,622	21-11015B05	220 pF, ±10%
C623	21-11014H29	15 pF
C624	21-11015B05	220 pF, ±10%
C625	08-11051A13	.1, 63V
C626	23-13749D39	.56, ±10%, 50V, tantalum
C627	23-13749D71	4.7, ±20%, 35V, tantalum
C628	21-11015B01	100pF, ±10%
C629	23-84538G06	47, ±20%, 20V, tantalum
C630	08-80027B08	3900
C631	08-11051A06	.0068, 63V
C632	08-11051A05	.0047, 63V
C633	08-11051A01	.001, 63V
C634	08-11051A07	.01, 63V
C635	21-11014H32	20 pF
C637	21-11014H32	20 pF
C638	23-82783B26	1, ±10%, 35V, tantalum
C639	08-80026B04	5, ±10%, 50V
C640	23-84762H20	.27, ±10%, 35V, tantalum
C641	08-83862M01	1, ±10%
diode (see note)		
CR600	48-82139G01	germanium
CR601	48-83329G02	silicon
CR602	48-84404E01	LED
connector receptacle		
J600	09-80001F01	phono jack
J601,602	09-83445L09	10 contact
J650	09-83730M01	7 contact
jumper		
JU600	06-11009F23	jumper
JU626	06-11009D23	jumper
coil, RF		
L600	24-83961B01	3 turns, silver-brown
L601	24-83884G06	4.5 turns, white
L602	24-83961B01	3 turns, silver-brown
L603,604	24-82723H45	10 uH, blue-red
L605	24-83397L07	10
L606	24-83961B01	3 turns, silver-brown
L607,608	24-82723H45	10 uH, blue-red
L609	24-82723H28	.29 uH, yellow
transistor (see note)		
Q600	48-00869706	NPN
Q601	48-00869681	PNP
Q602	48-00869839	JFET, N-channel
Q603	48-00869548	PNP
Q604	48-00869643	PNP
thermistor		
RT600	06-80275N01	1k, ±10%
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R600	06-11009C01	10
R601	06-11009C97	100k
R602	06-11009C93	68k
R603	06-11009C65	4.7k
R604	06-11009C89	47k
R605	06-11009C82	24k
R606	06-80036G35	2.7
R607	06-11009C17	47
R608	06-11009C33	220
R609	06-11009C25	100
R611	06-11009C49	1k
R612	06-11009C73	10k
R613,614	06-11009C67	5.6k
R615	06-11009C41	470
R616	06-11009C25	100
R617	06-11009C75	12k
R618	06-11009C49	1k
R619	06-11009C41	470
R620	06-11009C65	4.7k
R621	06-11009C73	10k
R622,623	06-11009C67	5.6k
R624	06-11009C29	150
R625	06-11009C44	620
R627	06-11009C57	2.2k
R628	06-11009C49	1k
R629	06-11009C01	10
R630	06-11009C56	2k
R631	06-11009C67	5.6k

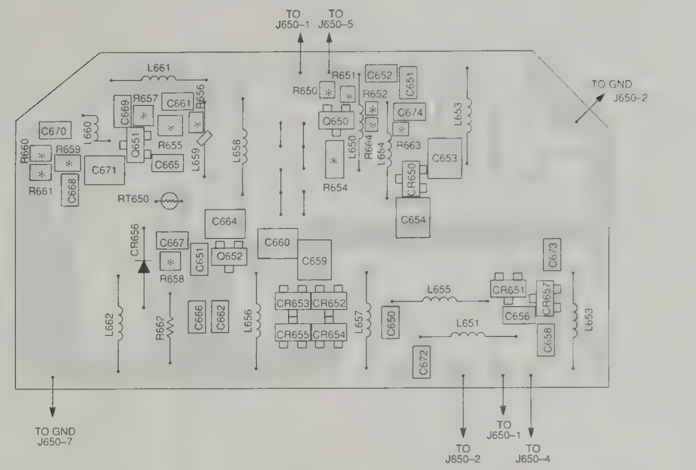
MXW-4595-B (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R632	06-11009C59	2.7k
R633	06-11009D06	220k
R634	06-11009C67	5.6k
R635	06-11009C85	33k
R636	06-11009C61	3.3k
R637	06-11009C57	2.2k
R638	06-11009C53	1.5k
R639	06-11009C87	39k
R700	06-11009C51	1.2k
integrated circuit (see note)		
U600	51-84768F65	low noise filter
U601	51-84768F68	prescaler
U602	51-83977M18	synthesizer
	or 51-84768F63	synthesizer
U603	51-83977M36	phase detector
U604	51-80072C01	2 input NOR gate
U605,606	51-80073C02	bilateral switch
U607	51-80073C03	bilateral switch
U608	51-80291B07	reference oscillator
	non-referenced parts	
	75-05295B01	crystal pad base, 6 used
	01-80707T23	shield and strap assembly
	26-83593M01	synthesizer component side shield
	55-84300B02	handle, 2
	37-00132562	heatshrink tubing
	01-80725T08	handle and shield assembly
	26-83592M01	component side shield
	03-80136F01	metric HI/LO screw
	05-84220B01	nylon snap-in rivet
	26-80055K01	can shield
	26-82270N01	shield
	26-83585M01	synthesizer solder side shield
	26-83586M01	6 pin filter shield
	26-83587M01	detector solder side shield
	26-83588M01	VCO solder side shield
	26-83594M01	component side shield, 8 used
	26-83595M01	detector component side shield
	26-83597M01	prescaler component side shield
	26-83814M01	fence shield
	37-00122064	tubing
	42-83891L01	mixer clip
	46-83948M01	RF board stud
	75-80193G01	shield pad

7/31/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN5356B VCO



* PARTS ARE SCREENED ON RESISTORS

SUBSTRATE GPW-6776-C
OVERLAY — GPW-6777-O

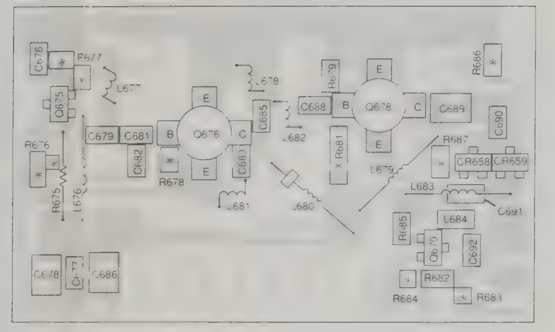
HLN5356B VCO (Talkaround) MXW-3337-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C650-652	21-84873H59	100
C653,654	21-11078B42	100, 100V
C656	21-84873H59	100
C657	21-11078A15	2.7, ±.25 pF, 100V
C658	21-84873H59	100
C659,660	21-11078B13	10, ±.5 pF, 100V
C661-663	21-84873H59	100
C664	21-11078B13	10, ±.5 pF, 100V
C665	21-44078A06	1.5, ±.25 pF
C666	21-84873H63	39
C667-670	21-84873H59	100
C671	21-11078B07	5.6, ±.25 pF, 100V
C672	08-80027B04	.039 uF, 100V
C673	21-11078A09	1.8, ±.25 pF
C674	21-84873H59	100
diode (see note)		
CR650	48-80236E19	common cathode, dual pin
CR651,655	48-82190H55	silicon
CR656	48-84616A11	hot carrier
CR657	48-82190H55	silicon
coil, RF		
L650,651	24-82723H40	290 nH, yellow black
L653-658	24-82723H40	290 nH, yellow black
L659	76-83960B01	ferrite core
L660	24-84331M46	airwound, 7 1/2 turns
L661-663	24-82723H40	290 nH, yellow black
connector		
P603	09-83729M01	7 contact
transistor (see note)		
Q650	48-84939C26	PNP
Q651	48-84411L54	NPN
Q652	48-84939C36	N-channel, FET
thermistor		
RT650	06-83241P03	300
	30-83361G01	coax cable, 50 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R650-652	—	non-replaceable parts
R654-661	—	non-replaceable parts
R662	06-11041D14	100k

7 24 89

note: For best performance, order diodes, transistors, and integrated-circuit devices by Motorola part number.

TRN8871D VCO BUFFER



* PARTS ARE SCREENED ON RESISTORS

SUBSTRATE GPW-6778-O
OVERLAY — GPW-6779-O

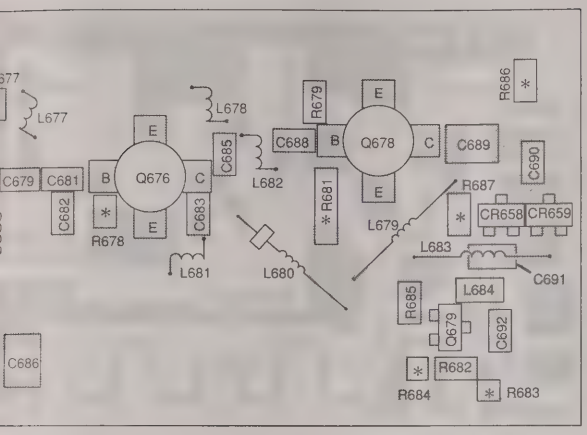
TRN8871D Hybrid VCO Buffer MXW-3338-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21-84873H59	100
C678	21-84547A13	.01 uF, ±10%
C681	21-84873H48	27, ±10%
C682	21-84873H01	3.3, ±.5 pF
C683	21-84873H56	8.2, ±.5 pF
C685	21-84873H63	39
C686	21-84873H44	39
C688	21-84296M05	5, ±.25 pF
C689	21-84873H16	22 pF
C690	21-05157A83	22 ±10%
C691	21-11031A29	39
C692	21-84873H63	39
diode (see note 1)		
CR658,659	48-80013E02	silicon pin
coil, RF		
L676	24-82723H40	290 nH, yellow black
L677	24-80091G08	airwound, 3 turns
L678	24-80091G21	airwound, 4 turns
L679,680	24-82723H40	290 nH, yellow black
L681	24-80091G21	airwound, 4 turns
L682	24-84331M46	airwound, 7 turns
L683	24-82723H40	290 nH, yellow black
L684	24-80140E07	680 nH
plug connector		
P101	28-84228048	male phono
transistor (see note 1)		
Q675	48-84411L54	NPN
Q676	48-84411L66	NPN
Q678	48-80225C08	NPN
Q679	48-80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06-11041C87	8.2k
R676-681	—(note 2)—	non-repairable screened parts
R679	06-11077A56	180
R682	06-11077A36	27
R685	06-11077B06	20k

4 26 88

notes:
1. For best performance, order diodes, transistors, and integrated-circuit devices by Motorola part number
2 Resistors are screened directly on substrate, and are not field replaceable

TRN8871D VCO BUFFER



SCREENED ON RESISTORS

SUBSTRATE GPW–6778–O
OVERLAY GPW–6779–O

TRN8871D Hybrid VCO Buffer MXW–3338–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21–84873H59	100
C678	21–84547A13	.01 uF, ±10%
C681	21–84873H48	27, ±10%
C682	21–84873H01	3.3, ±.5 pF
C683	21–84873H56	8.2, ±.5 pF
C685	21–84873H63	39
C686	21–84873H44	39
C688	21–84296M05	5, ±.25 pF
C689	21–84873H16	22 pF
C690	21–05157A83	22 ±10%
C691	21–11031A29	39
C692	21–84873H63	39
diode (see note 1)		
CR658,659	48–80013E02	silicon pin
coil, RF		
L676	24–82723H40	290 nH, yellow black
L677	24–80091G08	airwound, 3 turns
L678	24–80091G21	airwound, 4 turns
L679,680	24–82723H40	290 nH, yellow black
L681	24–80091G21	airwound, 4 turns
L682	24–84331M46	airwound, 7 turns
L683	24–82723H40	290 nH, yellow black
L684	24–80140E07	680 nH
plug connector		
P101	28–84228048	male phono
transistor (see note 1)		
Q675	48–84411L54	NPN
Q676	48–84411L66	NPN
Q678	48–80225C08	NPN
Q679	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06–11041C87	8.2k
R676–681	—(note 2)—	non–repairable screened parts
R679	06–11077A56	180
R682	06–11077A36	27
R685	06–11077B06	20k

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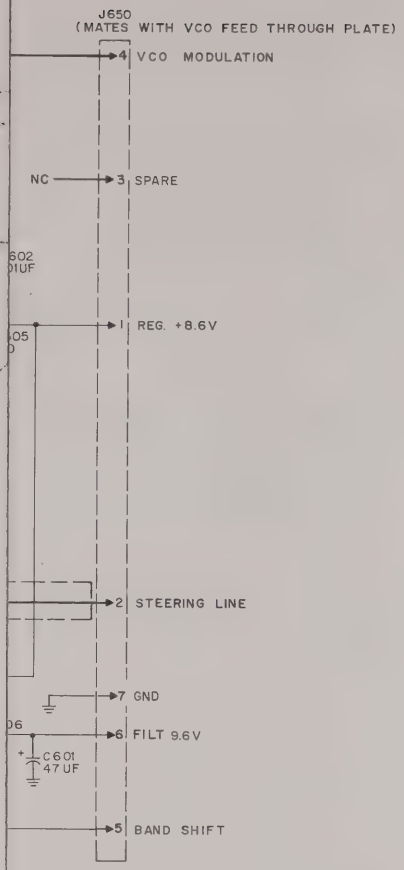
notes:
1. For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number.
2. Resistors are screened directly on substrate, and are not field replaceable.



stor values are in ohms, farads, and all inductor

-18 and capacitor C282 synthesizer sections of are shown on both the tic diagrams.

phase detector output lines) surround pins much of the adaptive

aptive filter section are ed 9.6 V source through 634 to ground. The sup- are: U604-14, U605-14, for these circuits is

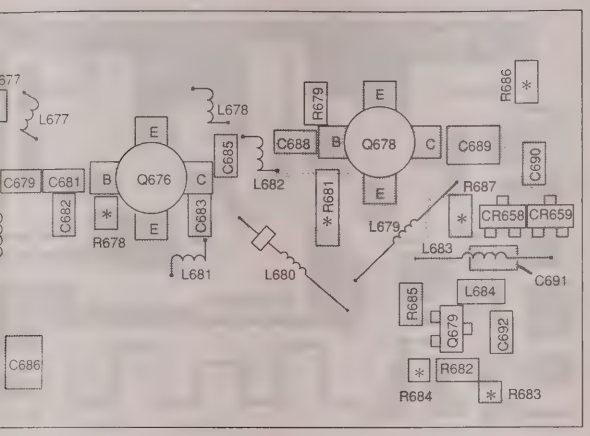
rconnect (Feedthrough ternal casting. J650 (on e side of the plate and onnected to the other. as pi-type filters in the .

erisk (*) are screened and are not field

cillator transmission line the lines between the oved from the circuit set– value.

Schematic, Circuit Board Diagrams, and Parts Lists
for RF Board (Frequency Synthesizer Section)
PW–3331–C
(Sheet 2 of 2)
6/30/89

TRN8871D VCO BUFFER



SCREENED ON RESISTORS

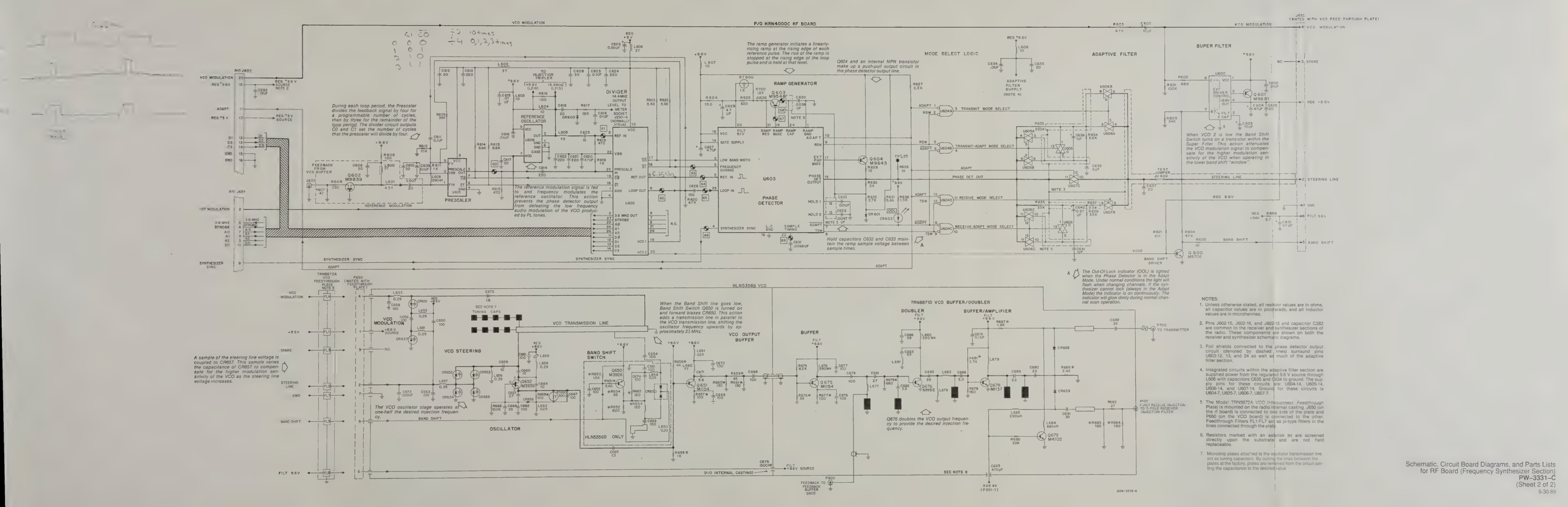
SUBSTRATE GPW–6778–O
OVERLAY GPW–6779–O

TRN8871D Hybrid VCO Buffer MXW–3338–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C676	21–84873H59	100
C678	21–84547A13	.01 uF, ±10%
C681	21–84873H48	27, ±10%
C682	21–84873H01	3.3, ±.5 pF
C683	21–84873H56	8.2, ±.5 pF
C685	21–84873H63	39
C686	21–84873H44	39
C688	21–84296M05	5, ±.25 pF
C689	21–84873H16	22 pF
C690	21–05157A83	22 ±10%
C691	21–11031A29	39
C692	21–84873H63	39
diode (see note 1)		
CR658,659	48–80013E02	silicon pin
coil, RF		
L676	24–82723H40	290 nH, yellow black
L677	24–80091G08	airwound, 3 turns
L678	24–80091G21	airwound, 4 turns
L679,680	24–82723H40	290 nH, yellow black
L681	24–80091G21	airwound, 4 turns
L682	24–84331M46	airwound, 7 turns
L683	24–82723H40	290 nH, yellow black
L684	24–80140E07	680 nH
plug connector		
P101	28–84228048	male phono
transistor (see note 1)		
Q675	48–84411L54	NPN
Q676	48–84411L66	NPN
Q678	48–80225C08	NPN
Q679	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R675	06–11041C87	8.2k
R676–681	—(note 2)—	non–repairable screened parts
R679	06–11077A56	180
R682	06–11077A36	27
R685	06–11077B06	20k

4/26/88

notes:
1. For best performance, order diodes, transistors, and integrated–circuit devices by Motorola part number.
2. Resistors are screened directly on substrate, and are not field replaceable.



NOTES:

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in picofarads, and all inductor values are in microhenries.
2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components are shown on both the receiver and synthesizer schematic diagrams.
3. Foil shields connected to the phase detector output circuit (denoted by dashed lines) surround pins U603-12, 13, and 24 as well as much of the adaptive filter section.
4. Integrated circuits within the adaptive filter section are supplied power from the regulated 9.6 V source through L606 with capacitors C635 and C634 to ground. The supply pins for these circuits are: U604-14, U605-14, U606-14, and U607-14. Ground for these circuits is U604-7, U605-7, U606-7, U607-7.
5. The Model TRN8872A VCO Interconnect Feedthrough Plate) is mounted on the radio internal casting. J650 (on the rf board) is connected to one side of the plate and P650 (on the VCO board) is connected to the other. Feedthrough Filters FL1-FL7 act as pi-type filters in the lines connected through the plate.
6. Resistors marked with an asterisk (*) are screened directly upon the substrate and are not field replaceable.
7. Microstrip plates attached to the oscillator transmission line act as tuning capacitors. By cutting the lines between the plates at the factory, plates are removed from the circuit setting the capacitance to the desired value.

Schematic, Circuit Board Diagrams, and Parts Lists for RF Board (Frequency Synthesizer Section)
PW–3331–C
(Sheet 2 of 2)
6-30-89

1. Description

The receiver section of the RF board is a dual conversion with intermediate frequencies of 53.9 MHz and 10.7 MHz. The factory–tuned preselector filter is wide enough to accommodate all frequencies in the band between 851 and 866 MHz without retuning.

The receiver circuits are in the RF internal casting, on the RF board, on the personality board, and on the common circuits board.

2. Theory of Operation

2.1 INTRODUCTION

The incoming RF signals go to the RF pre–amplifier via the antenna relay and a two–pole preselector filter. When the radio is in the transmit mode, DC power is removed from the pre–amplifier, and any transmitter power leaking through the open receive reed is shunted to ground by means of PIN diode switch, CR100.

The pre–amplifier output passes through a six–pole preselector filter then goes to the first mixer stage. The selectivity of the two–pole and six–pole preselector filters prevents high–level, out–of–band signals from degrading receiver performance.

The receiver does not use channel elements to generate the first mixer injection frequency. Rather, it takes the frequency synthesizer RF output, doubles it, then applies it to the first mixer via a three–pole injection filter. The first mixer, a balanced–diode type, uses low–side injection to generate a first intermediate frequency (IF) of 53.9 MHz.

The 53.9 MHz IF signal is coupled from the first mixer to the RF board via P/J203, then applied to the first IF amplifier. This amplifier uses a JFET (junction field–effect transistor) device in a common gate configuration. The amplified output signal passes through a 53.9 MHz two pole crystal filter and is then amplified by a second IF amplifier to make it strong enough to drive the second mixer.

The output of the frequency synthesizer's 14.4 MHz reference oscillator is split, and part of the signal is applied to the injection tripler. The injection tripler uses a Class C bipolar transistor amplifier to generate the required harmonics. Its output is tuned a a fixed injection frequency of 43.2 MHz. The second mixer uses the two input signals to generate a second intermediate frequency of 10.7 MHz. Low–side injection is also used in the second mixer.

2.2 SECOND IF CIRCUITRY

The second IF circuitry uses several stages of filtering and amplification. Dual resonator, mode coupled monolithic crystals cut to a fundamental frequency of 10.7 MHz filter the IF selectively. No tuning is required in the second IF or detector circuitry.

The second mixer output goes to the first four pole filter (Y250–Y251) via a matching network, and the output of the first four–pole filter goes to a matching network, then to a high–gain (approximately 45 dB) third IF amplifier (U250). The output of the third IF amplifier goes to a matching network, and second four–pole filter (Y252–Y253), a final matching circuit, and the limiter/detector (U251).

2.3 LIMITER/DETECTOR

The limiter/detector (U251) performs a limiting function and recovers audio from the frequency–modulated carrier. A quadrature detector inside the limiter/detector and an external two–pole dual resonator crystal recover audio from the second IF signal. The recovered audio goes from the limiter/detector through an emitter–follower buffer (Q250) to the audio stages on the personality board (via the personality board and the control unit). The detector buffer supplies approximately 650 millivolts to the control unit.

2.4 AUDIO AMPLIFIER AND SQUELCH MUTING CIRCUITRY

The audio amplifier and squelch muting circuitry is illustrated and described in the Microcomputer section of this manual.

2.5 SQUELCH CIRCUIT OPERATION

The squelch circuit is illustrated and described in the Common Circuits Board section of this manual.

2.6 RECEIVER METERING SOCKET

The receiver metering socket (J250) allows the following measurements to be made (see Table 1):

- J250–1 shows the relationship between the IF signal frequency and the quadrature detector center frequency.

Important

This should NOT be used for "warping" the radio onto frequency.

- J250–2 monitors the IF signal level at the input of the limiter/detector.
- J250–3 monitors the second mixer bias current, the proper injection level, and the high–level RF signals at the output of the second mixer.
- J250–4 measures the strength of the 14.4 MHz signal generated by the reference oscillator.
- J250–5 monitors the relative strength of the first mixer injection signal.

3. Receiver Troubleshooting Procedure

This procedure analyzes the loss of sensitivity in the receiver. See the list of Recommended Test Equipment in the Maintenance and Troubleshooting section of this manual.

(1) Perform the preliminary checks listed in Table 1. If all meter indications are correct, go to step 2.

(2) Apply a 20 millivolt signal to the antenna connector. If the meter indication at J250–3 rises above 40 µA, check the low IF (intermediate frequency) quad detector.

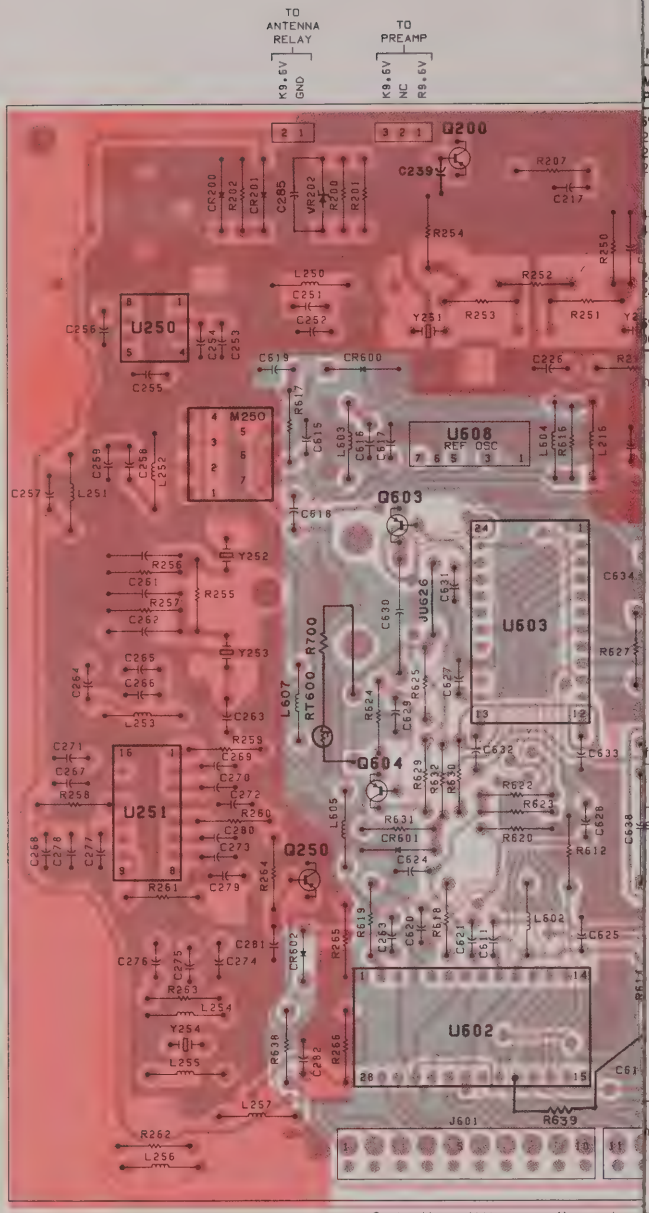
Note

The receiver schematic, at the end of this section, lists the correct meter voltages, RF voltages, and DC voltages for this part of the circuit.

If the meter indication at J250–3 is less than 40 µA, check the DC voltages of the pre–amplifier and the second IF (Q201, Q202, Q203, and Q204).

Table 1. Preliminary Receiver Checks

METERING SOCKET PIN	NORMAL INDICATION	IF INCORRECT
J250–1	25 +5 uA	Check the low IF and quad detector.
J250–2	15 uA +5 without signal 3–6 uA higher with 20 dB quieting signal.	Go to step 2 above.
J250–3	30 uA +5 or 2–3 uA higher when base of Q204 is shorted.	Check Q203.
J250–4	More than 10 uA.	Check reference oscillator output.
J250–5	More than 20 uA (meter may peg).	Check mixer diodes an dVCO signal at transmitter input.



Mixer MXW–3345–A

MOTOROLA PART NO.	DESCRIPTION
% (unless otherwise stated)	
21–82450B10	4.3, 500V
21–82187B11	1500, ±10%, 100V
21–00861603	3.3, ±.25 pF
48–84616A06	hot carrier
48–84616A11	hot carrier
24–84235B08	airwound, 1 1/2 turns
24–82723H28	290 nH, yellow
%, 1/8 watt (unless otherwise stated)	
06–11009C89	47k

4/26/88

nce, order diodes, transisters, and intergrated circuit devices by

fier MXW–3343–B

MOTOROLA PART NO.	DESCRIPTION
ss otherwise stated)	
21–13741M45	.01 uF, ±10%, 50V
21–13740A44	43 pF, ±5%, 50V
21–13740A27	8.2 pF, ±5%, 50V
21–11078A09	1.8 pF,±.25 pF, 100V
21–13740A44	43 pF, ±5%, 50V
21–13741M45	.01 uF, ±10%, 50V
21–13740A31	12 pF, ±5%, 50V
——	non–replacable parts
48–80010E02	pin
24–82723H40	.29 uH, yellow black
48–00869870	NPN
48–84939C23	PNP

6/30/89

mance, order diodes, transistors, and integrated circuit devices by

Schematic, Circuit Board Diagram, and Parts Lists for RF Board (Receiver Section)
PW–3340–C
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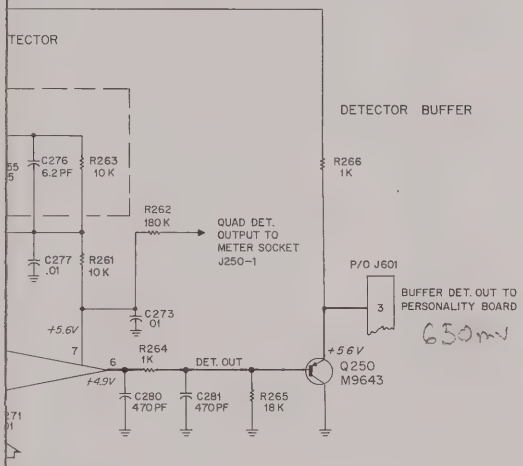
ANT
R6



/quadrature detector
d demodulates the

GW-3346-A

NOTES

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in microfarads, all inductor values are in microhenries.

2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components appear on both the receiver and synthesizer schematic diagrams.

Receiver Metering

Meter #	Function	Normal Indication (Approx.)
1	Quadrature detector center frequency	25 uA
2	2nd i-f signal level into limiter/detector	Idle 15 uA @ 20 dBq increases 5 uA
3	Second mixer with injection	30 uA
	With no injection (short base of Q204 to GND)	Increases 2-3 uA
4	Reference oscillator	15 uA
5	1st Mixer injection level	20 uA

Schematic, Circuit Board Diagram, and Parts Lists
for RF Board (Receiver Section)
PW–3340–C
(Sheet 2 of 2)
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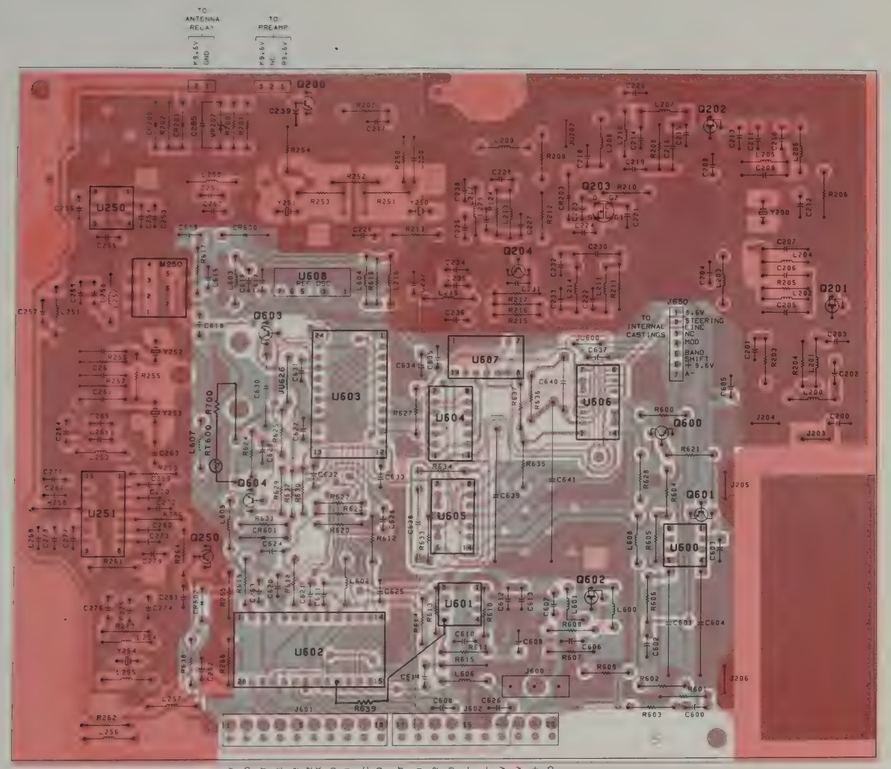


SOLDER SIDE GW-3332-A
COMPONENT SIDE GW-3333-A
OVERLAY GW-3334-B
OVERLAY GW-3341-O

Schematic, Circuit Board Diagram, and Parts Lists
for RF Board (Receiver Section)
PW-3340-C
(Sheet 1 of 2)
7/31/89

parts list

HRN4000C RF Circuit Board (Receiver section) MXW-4596-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 100V (unless otherwise stated)		
C200	21-11014H19	5.6 pF, ±.5 pF
C201	08-11051A07	.01, 63V
C202	08-11051A02	.0015, 63V
C203	21-11014H35	27 pF
C204	08-11051A02	.0015, 63V
C205,206	21-82450B13	1.5, 500V
C207	21-82450B32	2.7, 500V
C208	21-11014H32	20 pF
C209	21-82450B48	.75, 500V
C210	21-11014N14	6.8 pF, ±.5 pF
C211	21-11014H48	91 pF
C212	08-11051A02	.0015, 63V
C214	08-11051A07	.01, 63V
C215	21-11014H31	18 pF
C216	21-82450B19	1.8pF, 500V
C217	08-11051A07	.01, 63V
C218	23-13749D71	4.7, ±20%, 35V, tantalum
C219	21-11014H18	5.1 pF, ±.5 pF
C220	08-11051A02	.0015, 63V
C221	21-11014H19	5.6 pF, ±.5 pF
C222	08-11051A02	.0015, 63V
C223	21-11014H16	4.3 pF, ±.25 pF
C224	08-11051A07	.01, 63V
C225	21-11014H08	2 pF, ±.25 pF
C226	08-11051A07	.01, 63V
C227	21-11014H34	24 pF
C228	08-11051A07	.01, 63V
C229	21-11014H19	5.6 pF, ±.5 pF
C230	21-82450B08	1.2pF, 500V
C231	21-11014H19	5.6 pF, ±.5 pF
C232	21-11014H35	27 pF
C233	08-11051A02	.0015, 63V
C234	21-11014H45	68 pF
C235	21-11014H35	27 pF
C236	08-11051A02	.0015, 63V
C237	21-11014H46	75 pF
C238	21-11014H20	6.2 pF, ±.5 pF
C239	21-11015B15	1500, ±10%
C250	21-82450B37	.47, 500V
C251	21-11014H35	27 pF
C252	21-11014H40	43 pF
C253-255	08-11051A07	.01, 63V
C256	08-11051A13	.1, 63V
C257	08-11051A07	.01, 63V
C258	21-11014H35	27 pF
C259	21-11014H40	43 pF
C260,261	21-82450B08	1.2, 500V
C262	21-82450B37	.47, 500V
C263	21-11014H13	3.3 pF, ±.25 pF
C264	21-11014H33	22 pF
C265	21-11014H35	27 pF
C266	21-11014H39	39 pF
C267-273	08-11051A07	.01, 63V
C274	21-11014H40	43 pF
C275	21-11014H30	16 pF
C276	21-11014H20	6.2 pF, ±.5 pF
C277	08-11051A07	.01, 63V
C278	08-11051A13	.1, 63V
C279	08-11051A07	.01, 63V
C280,281	21-11015B09	470pF, ±10%
C282	08-11051A07	.01, 63V
C283	08-11051A01	.001, 63V
C284	08-11051A07	.01, 63V
C285	21-83406D64	5.6 pF, ±.25 pF, 500V
diode (see note)		
CR200,201	48-83654H01	silicon
CR203	48-83654H01	silicon
connector receptacle		
J200	28-84324M01	2 contact, male
J201	28-84324M02	3 contact, male
J202-206	42-83891L01	1 contact, female
J250	09-84207B01	7 contact, male
coil, RF		
L200	24-82723H28	.29 uH, yellow
L201	24-82723H45	10 uH, blue–red
L202	24-83397L12	1.2 uH, white
L203	24-82723H45	10 uH, blue–red
L204	24-83397L12	1.2 uH, white
L205	24-83397L13	.82 uH, gray–red
L206	24-82723H48	.085 uH, blue–orange
L207	24-82723H36	.41 uH, yellow
L208,209	24-82723H45	10 uH, blue–red
L210	24-83397L13	.82 uH, gray–red
L211	24-83397L12	1.2 uH, white
L212	76-83960B01	ferrite core
L213	24-82835G41	5.6 uH, green–blue–gold
L214	24-82723H36	.41 uH, yellow
L215	24-82723H37	6.2 uH, blue
L216	24-82723H45	10.0 uH, blue–red
L217	24-83397L08	15 uH, gray–gray
L218	76-83960B01	ferrite core
L250	24-83397L07	10
L251	24-82723H45	10 uH, blue–red
L252	24-83397L07	10
L253	24-82549D24	15 uH

MXW-4596-B (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L254,255	24-83397L08	15
L256,257	24-82723H45	10 uH, blue–red
transistor (see note)		
Q200	48-00869643	PNP
Q201,202	48-00869839	JFET, N–channel
Q203	48-84412L21	JFET, N–channel
Q204	48-00869932	NPN
Q250	48-00869643	PNP
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R200	06-11009C41	470
R201	06-11009C89	47k
R202	06-11009C73	10k
R203	06-11009C65	4.7k
R204	06-11009C27	120
R205	06-11009C59	2.7k
R206	06-11009C27	120
R207	06-11009C01	10
R208	06-11009C57	2.2k
R209	06-11009C51	1.2k
R210	06-11009C59	2.7k
R211	06-11009C73	10k
R212	06-11009C35	270
R213	06-11009C93	68k
R214	06-11009C59	2.7k
R215	06-11009C49	1k
R216	06-11009C65	4.7k
R217	06-11009C41	470
R250	06-11009C93	68k
R251	06-11009C01	10
R252	06-11009C41	470
R253	06-11009C01	10
R254	06-11009C93	68k
R255	06-11009C41	470
R256,257	06-11009C93	68k
R258	06-11009C99	120k
R259	06-11009C41	470
R260	06-11009C89	47k
R261	06-11009C73	10k
R262	06-11009D06	220k
R263	06-11009C73	10k
R264	06-11009C49	1k
R265	06-11009C79	18k
R266	06-11009C49	1k
integrated circuit (see note)		
U250	51-83977M55	IF amp
U251	51-80069C05	quad detector
voltage regulator (see note)		
VR202	48-83696E07	6.2V, zener
crystal (see note)		
Y200	48-83742M01	53.9 MHz
Y250	91-80011E04	10.7 MHz
Y251–254	91-80011E05	10.7 MHz

7/31/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

TRN8873B Internal Casting Hardware MXW-5344-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, feedthru, pF (unless otherwise stated)		
C114,115	21-82812H06	1000, +100, –0%, 500V
C153	21-82805H04	28, ±10%, 200V
C675	21-82543H01	1500, +100, –0%, 500V
C693	21-82812H05	470, +20%, 500V
coil, RF		
L100	24-80213B01	brown, includes C100
L101	24-80213B02	red
L110	24-80213B05	violet
L111	24-80213B03	blue
L112–115	24-80213B04	natural
L117	24-80213B08	green
L118	24-80213B07	yellow
L119	24-80213B06	orange
connector plug		
P201	—	consists of:
	15-84301K19	3 position connector housing
	39-82717M01	receptacle contact, 2 used
P600	28-82331G01	male
P700	28-82365D02	male
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R100	06-11041D14	100k
	mechanical parts	
	15-80230B03	internal casting
	05-00136977	eye
	28-82365D02	coax cable
	37-00132251	heatshrink tubing
	29-84407M01	lug connector
	29-83208M01	lug
	42-84074M01	ground strap
	28-84227B04	power connector
	64-83619M02	buffer carrier plate

4/26/88

note: for best performance, order diodes, transisters, and intergrated circuit devices by Motorola part number.

TRN8869A Hybrid First Mixer MXW-3345-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5% (unless otherwise stated)		
C150	21-82450B10	4.3, 500V
C151	21-82187B11	1500, ±10%, 100V
C152	21-00861603	3.3, ±.25 pF
diode (see note)		
CR150,151	48-84616A06	hot carrier
CR152	48-84616A11	hot carrier
coil, RF		
L151	24-84235B08	airwound, 1 1/2 turns
L153	24-82723H28	280 nH, yellow
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R150	06-11009C89	47k

4/26/88

note: for best performance, order diodes, transisters, and intergrated circuit devices by Motorola part number.

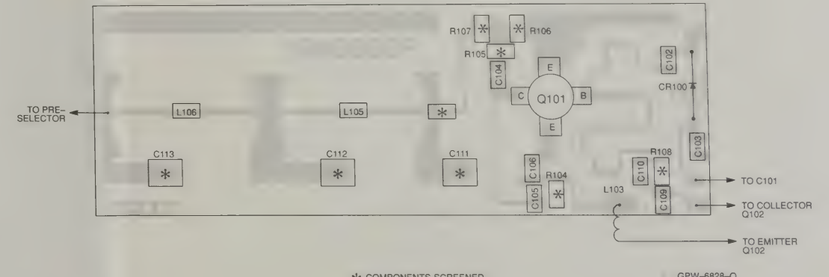
TRN8868A Pre–Amplifier MXW-3343-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C101	21-13741M45	.01 uF, ±10%, 50V
C102	21-13740A44	43 pF, ±5%, 50V
C103	21-13740A27	8.2 pF, ±5%, 50V
C104	21-11078A09	1.8 pF, ±.25 pF, 100V
C105–107	21-13740A44	43 pF, ±5%, 50V
C108,109	21-13741M45	.01 uF, ±10%, 50V
C110	21-13740A31	12 pF, ±5%, 50V
C111–113	——	non–replacable parts
diode (see note)		
CR100	48-80010E02	pin
coil, RF		
L103	24-82723H40	.29 uH, yellow black
transistor (see note)		
Q101	48-00869870	NPN
Q102	48-84939C23	PNP

6.30.89

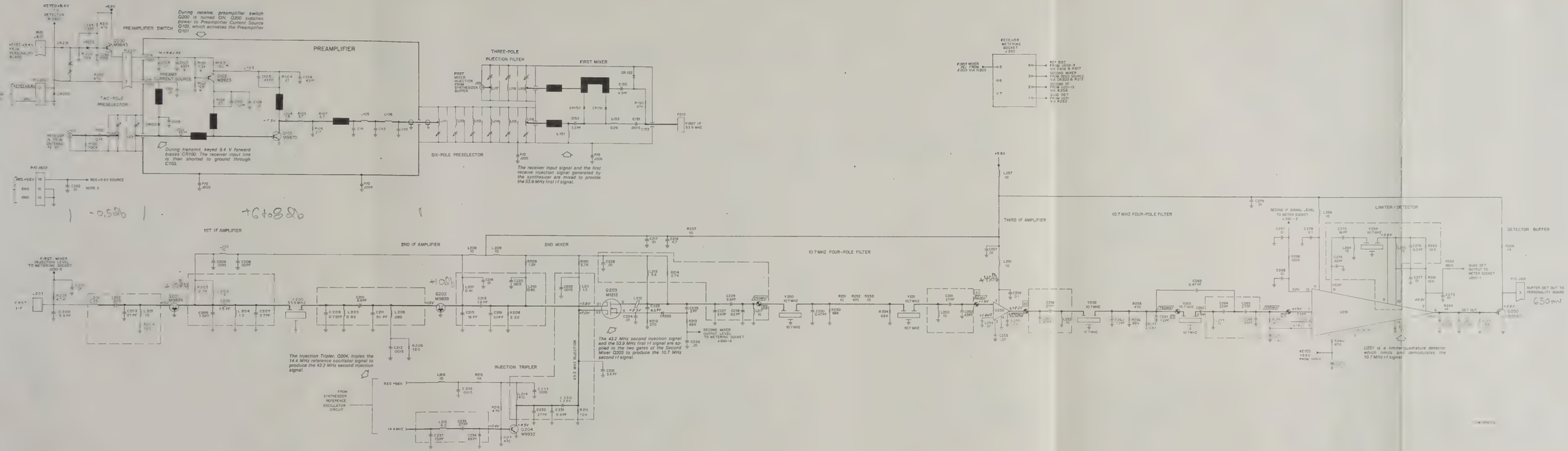
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

TRN8868A PREAMP



* COMPONENTS SCREENED DIRECTLY TO SUBSTRATE

GPW-6828-O
GPW-6829-O

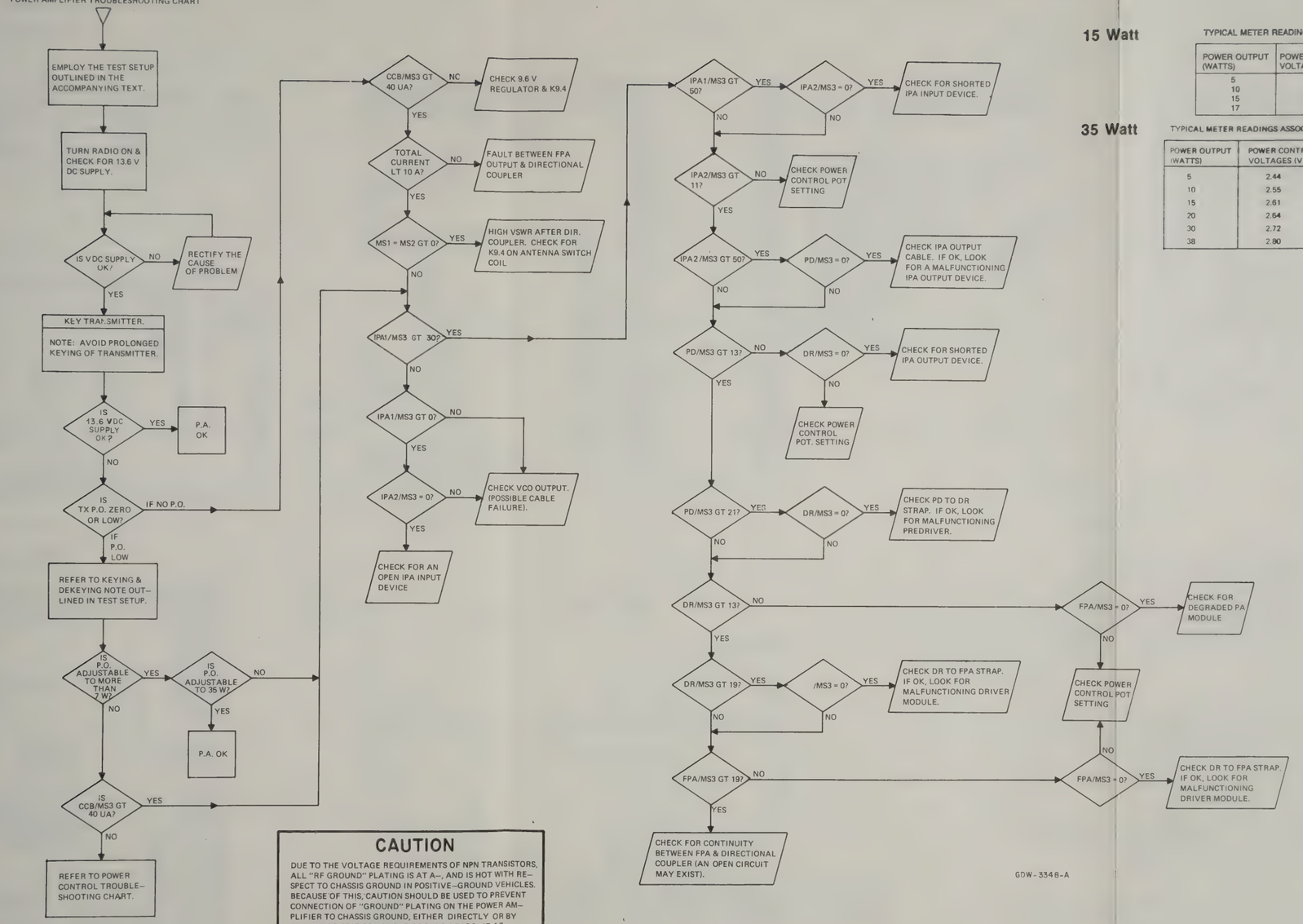


1 Unless otherwise indicated, all resistors are 1/4W, 5%, all capacitors are in microfarads, all inductors are in microhenries.

2 Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components appear on both the receiver and synthesizer schematic diagrams.

Receiver Metering		
Meter #	Function	Normal Indication (Approx.)
1	Quadrature detector center frequency	25 uA
2	2nd i.f. signal level into limiter/detector	60+ 15 uA @ 20 dBq
3	Second mixer with injection. With no injection (short base of Q204 to GND)	0 uA
4	Reference oscillator	13 uA
5	1st Mixer injection level	20 uA

Schematic, Circuit Board Diagram, and Parts Lists
for RF Board (Receiver Section)
PW-3340-C
(Sheet 2 of 2)
7 31 89



CAUTION

DUE TO THE VOLTAGE REQUIREMENTS OF NPN TRANSISTORS, ALL "RF GROUND" PLATING IS AT A–, AND IS HOT WITH RESPECT TO CHASSIS GROUND IN POSITIVE–GROUND VEHICLES. BECAUSE OF THIS, CAUTION SHOULD BE USED TO PREVENT CONNECTION OF "GROUND" PLATING ON THE POWER AMPLIFIER TO CHASSIS GROUND, EITHER DIRECTLY OR BY THE USE OF TEST EQUIPMENT GROUND LEADS. IF AC OPERATED TEST EQUIPMENT IS USED, THE GROUND LEAD MUST NOT BE ELECTRICALLY CONNECTED TO AC LINE GROUND. THIS CAUTION DOES NOT APPLY TO SYNTOR X2 TRUNKED RADIOS WITHOUT ACCESSORY INTERFACE OPTION W308.

15 Watt

TYPICAL METER READINGS ASSOCIATED WITH DIFFERENT POWER OUTPUT LEVELS

POWER OUTPUT (WATTS)	POWER CONTROL VOLTAGES (V)	TOTAL RADIO CURRENT (A)	P.A. METERING SOCKET READINGS (IN MICROAMPS)					
			MS1	MS2	IPA1/MS3	IPA2/MS3	PD/MS3	FPA/MS3
5	2.44	3.3	4.0	0	27	11	22	12
10	2.55	3.8	6.0	0	36	11	22	13
15	2.61	4.3	10.0	0	37	12	23	14
17	2.64	4.6	12.0	0	37	13	23	14

35 Watt

TYPICAL METER READINGS ASSOCIATED WITH DIFFERENT POWER OUTPUT LEVELS

POWER OUTPUT (WATTS)	POWER CONTROL VOLTAGES (V)	TOTAL RADIO CURRENT (A)	P.A. METERING SOCKET READINGS (IN MICROAMPS)						
			MS1	MS2	IPA1/MS3	IPA2/MS3	PD/MS3	DR/MS3	FPA/MS3
5	2.44	3.7	4.0	0	27	11	16	10	13
10	2.55	5.0	6.0	0	36	11	17	10	15
15	2.61	6.2	10.0	0	37	12	17	11	16
20	2.64	7.0	12.0	0	37	13	17	13	17
30	2.72	8.5	15.0	0	37	13.5	18	15	19
38	2.80	9.6	18.0	0	37	14	18	16	22

SYMBOLS AND ABBREVIATIONS USED IN THIS FLOWCHART

= DECISION BOX

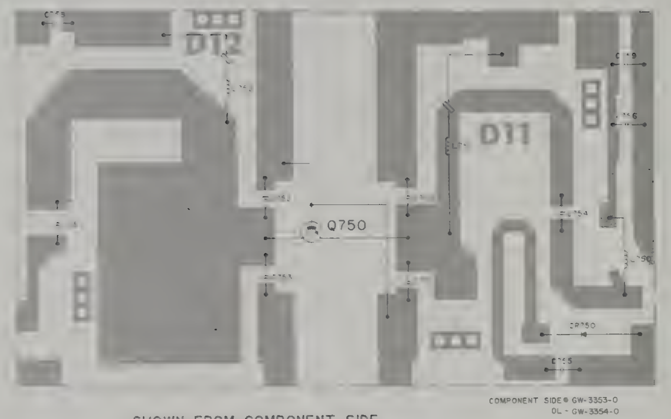
= ACTION TO BE TAKEN

= POSSIBLE LOCATION OF FAULT. DEFECTIVE COMPONENTS TO BE REPLACED.

P.O.	POWER OUTPUT
P.A.	POWER AMPLIFIER
FPA	FINAL POWER AMPLIFIER
IPA	INTERMEDIATE POWER AMPLIFIER
IPA1	INTERMEDIATE POWER AMPLIFIER NO. 1
IPA2	INTERMEDIATE POWER AMPLIFIER NO. 2
PD	PREDRIVER
DR	DRIVER
CCB	COMMON CIRCUIT BOARD
MS3	PIN NO. 3 OF THE METERING SOCKET
IPA1/MS3	PIN NO. 3 OF METERING SOCKET ASSOCIATED WITH INTERMEDIATE P.A. NO. 1. THE METERING SOCKET IS LOCATED ON P.A. BOARD. OTHERS ARE IPA2/MS3, FPA/MS3, PD/MS3, DR/MS3.
CCB/MS3	PIN NO. 3 OF METERING SOCKET LOCATED ON THE COMMON CIRCUITS BOARD.
GT	GREATER THAN, USED FOR COMPARISON.
GE	GREATER THAN OR EQUAL, USED FOR COMPARISON.
LT	LESS THAN, USED FOR COMPARISON.
LE	LESS THAN OR EQUAL, USED FOR COMPARISON.

Power Amplifier Troubleshooting Chart
PW-3349-A
5/13/87

PREDRIVER



SHOWN FROM COMPONENT SIDE

TRN8852A Predriver — MXW-3375-B

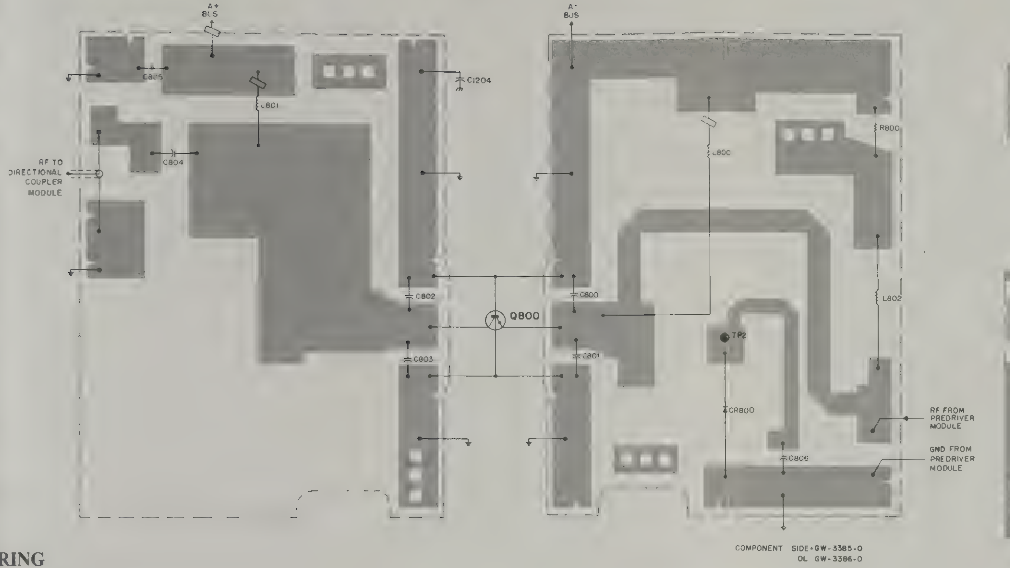
REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C750,751	21-11078B06	5.1 pF, ±.25 pF, 100V
C752,753	21-11078B15	12 pF, ±5%, 100V
C754-756	21-13740A43	39 pF, ±5%, 50V
C757	21-11078B15	12 pF, ±5%, 100V
C758	21-13740A31	12 pF, ±5%, 50V
C759	21-13741M45	.01 uF, ±10%, 50V
diode (see note)		
CR750	48-84616A11	hot carrier
coil, RF		
L750	24-80091G16	airwound, 11 turns
L751,752	24-80089G03	ferrite, 3 turns
transistor (see note)		
Q750	48-00869875	NPN
	non-referenced items	
	29-83208M01	lug, 3 used
	42-80164B01	substrate retainer
	42-80165B02	substrate retainer clip, 2 used
	64-80202K01	ground strap
	84-83111M01	circuit board substrate, input
	84-83112M01	circuit board substrate, output

6/30/89

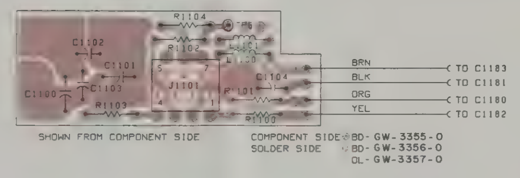
note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

Schematic, Circuit Board Diagrams, and Parts List for 15W Power Amplifier
PW-2635-C
(Sheet 1 of 2)
6/30/89

FINAL PA



PA METERING



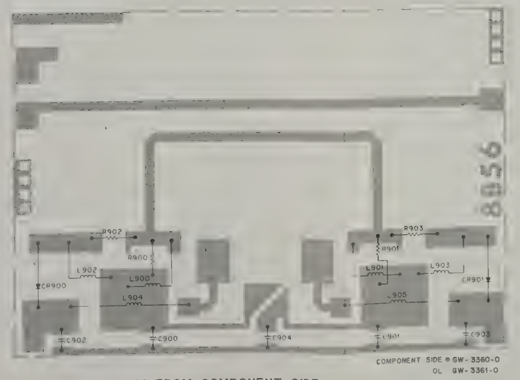
TRN8855B Metering Board — MXW-3372-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C1100,1101	08-84637L25	.01 uF, ±10%, 400V
C1102	23-13749D71	4.7 uF, ±20%, 35V, tantalum
C1103,1104	21-83406D64	5.6 pF, ±.25 pF, 500V
connector receptacle		
J1101	09-84207B01	7 contact
coil, RF		
L1100,1101	24-82723H28	.29uH yellow
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R1100,1101	06-11009C97	100k
R1102	06-11009C85	33k
R1103	06-11009D14	470k
R1104	06-11009C49	1k
transformer		
TP6	28-84528K21	1 pin circuit board
	non-referenced items	
	84-83088M02	circuit board
	29-82713M01	terminal, 7 used
	29-84706E06	terminal, 4 used

6/30/89

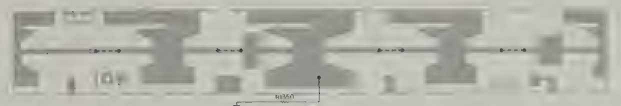
note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

DIRECTIONAL COUPLER



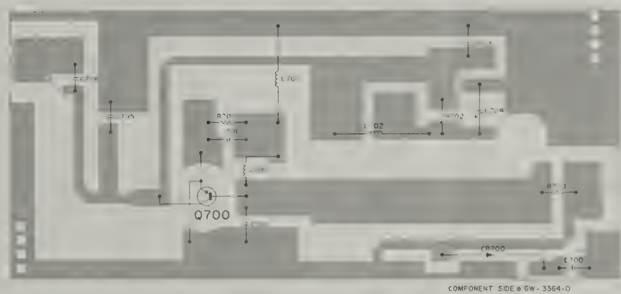
SHOWN FROM COMPONENT SIDE

HARMONIC FILTER



SHOWN FROM COMPONENT SIDE

IPA INPUT



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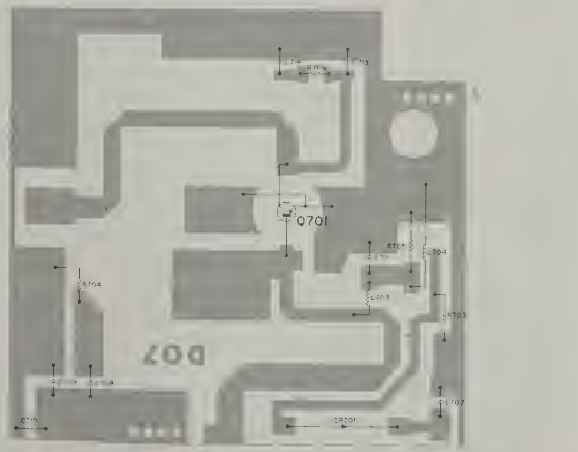
IPA OUTPUT



SHOWN FROM COMPONENT SIDE

parts list

HLN5108A Power Amplifier Hardware Kit — MXW-2650-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed
C1180-1187	21-82812H03	feedthru, .001 µF +100, -0%, 500V
C1200-1203	21-83406D64	5.6 pF ±.25 pF, 500V
C1204	21-82187B14	.001 µF ±10%, 100V
		connector, plug
P951	—	consists of:
	15-84301K04	connector housing, 6-contact
	39-82717M01	receptacle contact, 5 used
	28-84302K01	polarizing key plug
	non-referenced items	
	04-00114522	lock washer (⅝" int.)
	04-83755H01	shoulder washer, 8 used
	30-83794C01	coax cable, 14.44" used
	32-80080A01	antenna connector gasket
	32-83896M01	RF gasket
	42-35424B01	tie strap, 9 used
	42-80013A01	coax clip
	76-84069B04	ferrite bead, 11 used
	64-80122B01	feedthru plate
	30-83361G01	coax cable, 4.75" used
	76-83466K01	ferrite bead, 2 used
	01-80743T02	coax assembly
	01-80743T03	coax stub

TRN8857A Bus Wiring Kit — MXW-3371-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (see note)		
C1188	23-82747L24	470 uF, -10, +100%, 20V, electrolytic
diode (see note)		
CR1181	48-80153A01	silicon (pellet)
	non-referenced items	
	01-80724D24	wire and lug assembly includes.
	29-83897M01	single contact terminal
	37-00132251	black heatshrink tubing
	01-80724D25	wire and lug assembly includes
	29-83897M01	single contact terminal
	37-00132251	black heatshrink tubing
	15-83499M01	bus boss housing
	39-83495M01	bus boss contact (right)
	39-83496M01	bus boss contact (left)
	42-10217A02	nylon tie strap

5/10/88

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8856A Directional Coupler — MXW-3373-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C900-904	21-13740A43	39 pF, ±10%, 50V
C905	21-11078B32	39 pF, ±5%, 100V
diode (see note)		
CR900,901	48-84616A01	hot carrier
coil, RF		
L900,901	24-84331M47	airwound, 7 turns
L902,903	24-80091G16	airwound, 11 turns
L904,905	24-82723H40	.29 uH
	non-referenced items	
	29-83208M01	lug, 3 used
	07-83481M01	directional coupler frame
	84-83129M01	circuit board substrate

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8850A Harmonic Filter Module — MXW-3378-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1350	06-11009C97	100k, ±5%, 1/4W
M1	07-80123B01	harmonic filter frame

5/10/88

TRN8851A Intermediate Power Amplifier — MXW-3374-B

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C700	21-13740A43	39 pF, ±10%, 50V
C701	21-13740A31	12 pF, ±5%, 50V
C702	21-84873H75	7 pF, ±.25 pF, 50V
C703	21-13740A43	39 pF ±10% 50V
C704	23-84677D06	1 uF, ±10%, 20V, tantalum
C705	21-13740A55	100 pF ±5% 50V
C706,707	21-13740A43	39 pF, ±10%, 50V
C708	21-13741M45	.01 uF ±10% 50V tantalum
C709	21-13740A43	39 pF ±10% 50V
C710	21-84873H75	7 pF, ±.25 pF, 50V
C711	21-13740A39	27 pF ±5%, 50V
C712	21-13740A29	10 pF ±5%, 50V
C713	21-13740A43	39 pF ±10%, 50V
C714	21-13741M45	.01 uF, ±10% 50V tantalum
diode (see note)		
CR700,701	48-84616A11	hot carrier
connector receptacle		
J700	01-80719D61	phono plug assembly
coil, RF		
L700	24-80091G20	airwound
L701,702	24-82723H40	.29 uH, yellow black
L703	24-80091G20	airwound
L704	24-82723H40	.29 uH, yellow black
transistor (see note)		
Q700	48-80225C08	NPN
Q701	48-84411L39	NPN
	non-referenced items	
	02-00007003	nut (8-32 x 5/16 x 1/8), 8 used
	05-10281A10	nylon rivet
	42-10217A02	nylon tie wrap
	01-80719D61	IPA assembly plate
	09-83577M01	connector
	29-80177B01	coax terminal
	37-00132562	heatshrink tubing
	01-80719D98	IPA black input wire assembly
	01-80719D99	IPA red input wire assembly
	29-84706E06	chain terminal, 2 used
	84-83107M01	circuit board, output substrate
	84-83105M01	circuit board, input substrate

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

HLN5107A Final Power Amplifier Module — MXW-2651-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, pF, fixed ±5%, 50V unless otherwise stated
C800-803	21-84736E08	16
C804	21-84736E12	39
C805, 806	21-84873H63	39
		coil
L800, 801	24-80089G02	3 turns
L802	24-80089G03	ferrite bead, 3 turns
		resistor, Ω, fixed
R800	06-11041C41	100 ±5%, ¼W
	non-referenced items	
	29-83208M01	solder lug, 3 used
	42-80164B01	substrate retainer
	42-80165B02	substrate retainer clip, 2 used

note: Field repair of this kit is not recommended. It should be replaced in its entirety. These parts are listed for reference purposes only.

TRN8868A Pre-Amplifier — MXW-3343-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C101	21-13741M45	.01 uF, ±10%, 50V
C102	21-13740A44	43 pF, ±5%, 50V
C103	21-13740A27	8.2 pF, ±5%, 50V
C104	21-11078A09	1.8 pF, ±.25 pF, 100V
C105-107	21-13740A44	43 pF, ±5%, 50V
C108,109	21-13741M45	.01 uF, ±10%, 50V
C110	21-13740A31	12 pF, ±5%, 50V
C111-113	——	non-replacable parts
diode (see note)		
CR100	48-80010E02	pin
coil, RF		
L103	24-82723H40	.29 uH, yellow black
transistor (see note)		
Q101	48-00869870	NPN
Q102	48-84939C23	PNP

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

TRN8853A Driver Module — MXW-3376-B

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C800,801	21-11078B06	5.1 pF ±.25 pF 100V
C802,803	21-11078B15	12 pF, ±5% 100V
C804	21-11078B32	39 pF ±5% 100V
C805	21-13740A39	27 pF ±5% 50V
C806	21-13740A43	39 pF ±5%, 50V
diode (see note)		
CR850	48-84616A11	hot carrier
coil, RF		
L800,801	24-80089G03	ferrite 3 turns
L802	24-80089G02	airwound 3 turns
transistor (see note)		
Q800	48-00869876	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R800	06-11041C17	10
	non-referenced items	
	29-83208M01	lug 2 used
	42-80164B01	substrate retainer
	42-80165B02	substrate retainer clip 2 used
	64-80202K01	ground strap
	84-83115M01	circuit board substrate, input
	84-83116M01	circuit board substrate output

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8854A Final Amplifier — MXW-3377-B

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C850-857	21-11078B15	12 pF ±5%, 100V
C859-861	21-11078B32	39 pF ±5% 100V
C862	21-13741M45	.01 uF ±10% 50V
C863,864	21-13740A31	12 pF ±10%, 50V
C865	21-13740A43	39 pF ±10% 50V
diode (see note)		
CR850	48-84616A11	hot carrier
coil, RF		
L850-852	24-80089G01	ferrite 3 turns
transistor (see note)		
Q850,851	48-84411L43	NPN
thermistor		
RT850	06-82696B01	thermistor
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R851	06-11009C01	10
	non-referenced items	
	42-80163B03	connecting strap
	42-84417K01	substrate holder
	84-83117M01	circuit board substrate input
	84-83118M01	circuit board substrate output

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

35–Watt and 15–Watt Power Amplifier Deck

1. Theory of Operation

The 35 and 15–watt power amplifier decks are a microstrip design that uses ceramic substrate boards. The stages consist of 50–ohm blocks with Class C amplifier circuitry. The power amplifier has two major sections: the intermediate power amplifier (IPA) and the final power amplifier (PA).

The RF output generated by the frequency synthesizer at the required transmit carrier frequency is applied to the controlled stage of the IPA (Q700). The gain of the controlled stage and the output power of the radio can be changed by varying the control voltage. The IPA output stage (Q701) is driven by the controlled stage. DC power for the IPA output stage is supplied via the output coaxial cable. The IPA module has a rated output power of 1.2–watts.

The RF signal from the IPA is applied to the final power amplifier. The final power amplifier consists of two stages; the predriver stage and the driver stage in the 35–watt and the predriver stage and the final PA in the 15–watt. Each stage is mounted on separate microstrip assemblies.

For 35–watt models, the predriver can output 4.5–watts while the driver can output 18–watts.

For 15–watt models, the predriver can output 5–watts while the final PA can output 21–watts.

The 35–watt final power amplifier contains two power transistors (Q850 and Q851) that operate in parallel. The 15–watt contains one power transistor (Q800) stage. Temperature–sensing circuitry works in conjunction with the RF power control circuit, on the common circuit board, to reduce the output power of the radio whenever the temperature of either power transistor exceeds 80°C.

The RF power output from the final amplifier module goes to a directional coupler that measures forward and reflected power. Information related to the forward and reflected power goes to the RF power control circuit on the common circuits board. This circuit reacts to any change in power by changing the RF drive to restore the RF power output to its original level.

When the VSWR (voltage standing wave ratio) at the radio output connector approaches a level that can damage the final power transistors, the power control circuitry reacts by reducing the RF power output to a predetermined safe level (6 to 10–watts). The RF output of the directional coupler is routed to the antenna via a harmonic filter and the antenna switch. The directional coupler can handle at least 50–watts of RF output power for the 35–watt PA or 15–watt PA.

The power amplifier uses metering socket (J1101) to facilitate the following measurements.

- J1101–1 and J1101–2 (pins 1 and 2 of the metering socket) permit checking of the directional coupler outputs. J1101–1 is at a DC voltage proportional to the forward power level, and J1101–2 is at a DC voltage proportional to the reflected power level. (J952–1 and J952–2 on the common circuits board are at the same voltages.)

- The power amplifier deck has an RF detector at the input of each stage. All of the RF detectors are used in conjunction with pin 3 (J1101–3) of the metering socket. To measure the RF input to any stage, use a jumper to connect J1101–3 to the RF detector of the stage being checked. See note 2 and the jumper table on the power amplifier schematic.

- J1101–4 is used to measure the power amplifier deck supply voltage.

2. Power Amplifier Troubleshooting Procedure

2.1 PREREQUISITE TEST SETUP

Note

Before you perform any measurements on the power amplifier deck, see the transmitter power paragraphs in the Maintenance Section of this manual.

(1) Connect the radio antenna connector to a wattmeter terminated in a 50–ohm dummy load. As indicated in the maintenance section, be sure that the wattmeter, load, and interconnect cable are rated for use at 800 MHz.

(2) Connect the radio to a 13.6 volt DC power source supply capable of supplying at least the maximum transmit current specified for the radio.

(3) Use a TEK–37 Test Set Adapter to connect a Motorola S1056 Portable Test Set to the radio as follows.

- Connect the 20–pin connector of the test set adapter to the receptacle on the front panel of the portable test set.
- Connect the white "metering" plug of the test set adapter to the power amplifier deck metering socket J1101.

(4) Set the portable test set switches as follows:

- Set the FUNCTION switch to the XMTR position,
- Set the METER switch to the REV position,
- Set the test set adapter REF switch to Position A,
- Set the test set adapter 1 volt/100 millivolt switch to the 100 millivolt position. (If the test set adapter is not provided with such a switch, the adapter operates at 100 millivolt at all times.)

(5) Before operating any equipment, see the "CAUTION" on the power amplifier troubleshooting chart. Be sure all AC operated test equipment units are isolated from the AC line ground, especially on positive ground modified radios where the power amplifier deck ground structure "floats."

(6) Because of the power control shutback function, the power amplifier deck output power may range between five and ten watts. See the output power setting procedure to determine whether or not shutback is occurring.

2.2. INTERPRETATION OF POWER OUTPUT TABLE

See the power output table shown on the power amplifier troubleshooting chart. This table displays typical (not absolute) meter readings along with power control voltages and total current levels for different power outputs. This table can help to determine when the performance of a power amplifier deck module has deteriorated below accepted levels. Check amplifier deck performance as follows:

(1) Turn power output control (POC) R979 fully counterclockwise (from the top of the radio).

(2) Set the power output to a low level.

(3) Take the meter readings required and compare them with those provided in the table. For example, see Table 1 for a five–watt power output.

Table 1. Five–Watt Power Output Conditions for 35 and 15–watt PA's

CONDITION	15–WATT	35–WATT
POWER CONTROL VOLTAGE	2.44V	2.44V
TOTAL RADIO CURRENT	3.3 A	3.7 A
J1101–1	8.0 uA	4.0 uA
J1101–2	0.0 uA	0.0 uA
IPA1/J1101–3	27.0 uA	27.0 uA
IPA2/J1101–3	11.0 uA	11.0 uA
PREDRIVER/J1101–3	21.0 uA	16.0 uA
DRIVER/J1101–3	—	10.0 uA
FINAL PA/J1101–3	9.0 uA	13.0 uA

Note

The readings obtained from a degraded module will be lower than the typical readings provided by the table.

When the gain of a power amplifier deck module stage degrades, the power control circuit attempts to increase the power level. This results in providing more drive power to the modules preceding the faulty stage.

Table 1 shows that J1101–3 (pin 3 of the power amplifier deck metering socket) is associated with IPA1, IPA2, predriver, and final power amplifier. The various J1101–3 readings are obtained by jumpering between TP6 (on the metering board) and the test points on the various modules. Figure 1 and Table 2 show the various J1101–3/TP6 connections.

Table 2. PA Test Point Jumpering

CONNECT	TO	TESTING
TP6	TP1	driver (35W)
TP6	TP2	predriver
TP6	TP3	IPA output
TP6	TP4	IPA input
TP6	TP5	transmit injection

2.3 TROUBLESHOOTING PROCEDURE

(1) See the symbols and abbreviations shown on the power amplifier troubleshooting chart, as well as on the "CAUTION" and typical meter readings table on the diagram.

(2) Follow the step–by–step procedure outlined on the troubleshooting chart.

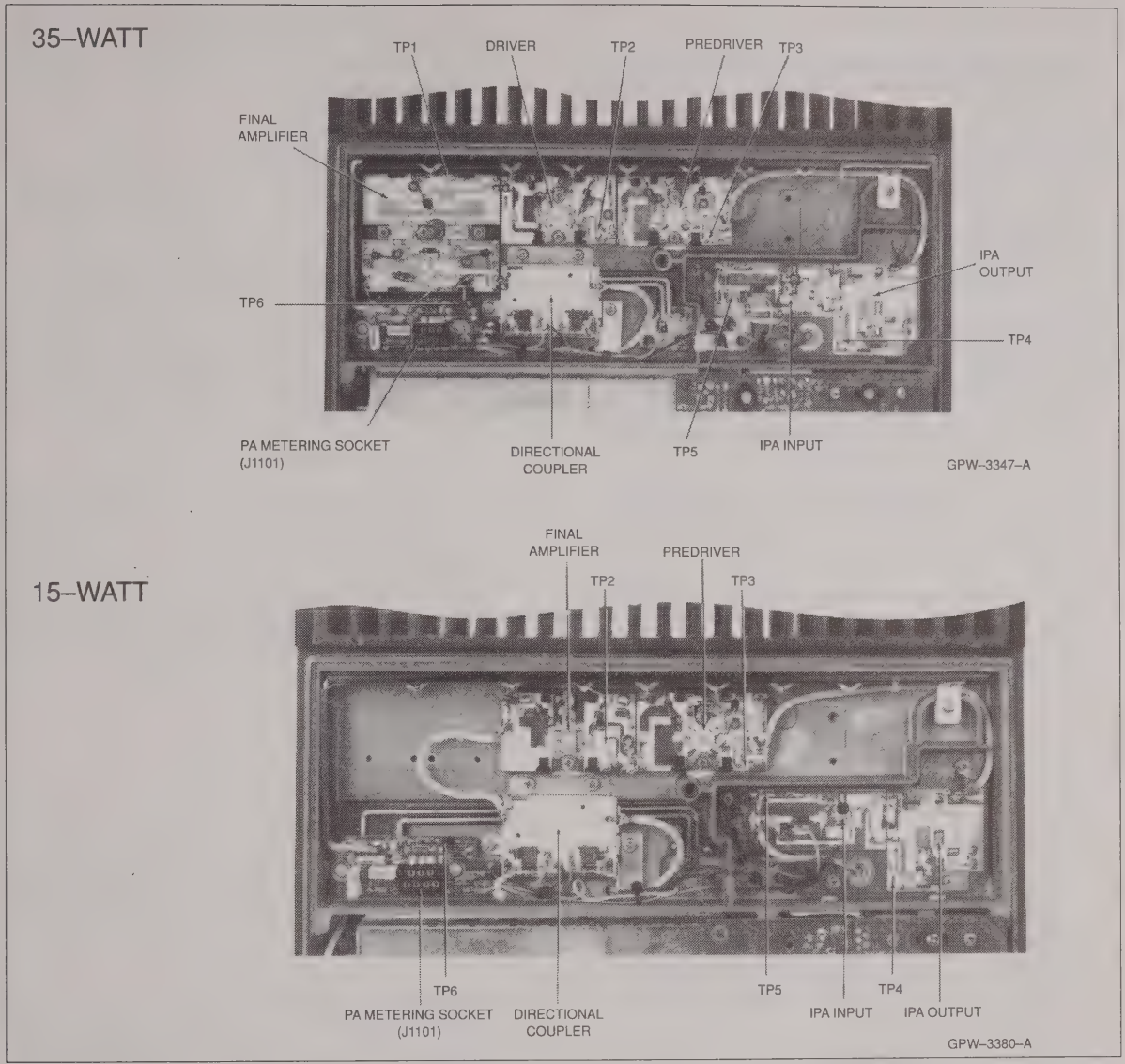


Figure 1. Power Amplifier J1101–3 Connections

3. RF Power Control Troubleshooting Procedure

The RF power control troubleshooting procedure (as shown in the associated troubleshooting charts) consists of:

- Insufficient power output,
- Lack of power control,
- VSWR protection,
- Low–line cutback,
- High–drive protection.

CAUTION

Voltages in the power control become critical only during transmissions. Therefore you must key the radio in order to take measurements. Briefly key the radio during to take the measurement. Avoid continuous keying; this can put the power control into protective shut back, and cause the generation of erroneous and confusing symptoms.

Note

All voltage measurements are referenced to A– (PA "floating" GND).

3.1 INSUFFICIENT POWER OUTPUT

(1) Perform the steps specified in the insufficient power output section of the RF power control troubleshooting chart.

(2) After locating and correcting the fault, perform the following checks:

- VSWR protection,
- Low–line cutback,
- High–drive protection.

3.2 LACK OF POWER CONTROL

If there is sufficient power output but you cannot adjust the power control, proceed as follows:

(1) Perform the steps specified in the lack of power control test procedure of the RF power control troubleshooting chart.

(2) After locating and correcting the fault, perform the following checks:

- VSWR protection,
- Low–line cutback,
- High–drive protection.

Note

If the power amplifier deck fails, the power control protection functions are probably not operating properly. Therefore you should perform the three checks listed above. You should also perform these checks after completing the insufficient power output procedure or the lack of power control procedure.

3.3 VSWR PROTECTION TEST

3.3.1 35–Watt Amplifier

(1) Use the standard test setup as described in the test setup in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load.

(3) Briefly key the radio and adjust the power output control (POC) R979 until a power output indication of 38 ±1.5–watts is obtained for all operating frequencies.

Note

Avoid extended keying of the radio.

(4) Remove the 50–ohm load from the radio. Briefly key the radio again and verify that an output power of approximately 6.3–watts (one–sixth of the nominal power) is obtained for all operating frequencies. Also verify that the voltage indication on U950–8 is greater than 7 V. If either or both indications are incorrect, see the VSWR protection test procedure of the RF power control troubleshooting chart.

3.3.2 15–Watt Amplifier

(1) Use the standard test setup as described in the test setup in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load.

(3) Briefly key the radio and adjust the power output control (POC) R979 until a power output indication of 17 ±1.5–watts is obtained for all operating frequencies.

Note

Avoid extended keying of the radio.

(4) Remove the 50–ohm load from the radio. Briefly key the radio again and verify that an output power of approximately 4.0–watts (one–fourth of the nominal power) is obtained for all operating frequencies. Also verify that the voltage indication on U950–8 is greater than 0.5 V. If either or both indications are incorrect, see the VSWR protection test procedure of the RF power control troubleshooting chart.

3.4 LOW–LINE CUTBACK TEST

3.4.1 35–Watt Amplifier

(1) Use the standard test setup as described in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load. Set the power supply output voltage to 13.6 V. Briefly key the radio and adjust the POC until an output power indication of 38–watts is obtained.

(3) De–key the radio and reduce the power supply volt age to 10.8 V. Re–key the radio and verify that the output power is approximately 20–watts. If the output power indication is wrong, perform the steps outlined in the low–line cutback test procedure of the RF power control troubleshooting chart.

3.4.2 15–Watt Amplifier

(1) Use the standard test setup as described in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load. Set the power supply output voltage to 13.6 V. Briefly key the radio and adjust the POC until an output power indication of 17–watts is obtained.

(3) De–key the radio and reduce the power supply volt age to 10.8 V. Re–key the radio and verify that the output power is approximately 9.0–watts. If the output power indication is wrong, perform the steps outlined in the low–line cutback test procedure of the RF power control troubleshooting chart.

3.5 HIGH–DRIVE PROTECTION TEST

3.5.1 35–Watt Amplifier

(1) Use the standard test setup as described in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load. Set the power supply voltage to 13.6 V. Adjust the power output to 38–watts.

(3) Measure the collector voltage of Q952. It should be greater than 1.0 V. With radio de–keyed, disconnect P951. Re–key the radio and remeasure the collector voltage of Q952. The voltage measurement should now be less than 0.1 V if the high–drive protection circuit is functioning properly. If the voltage measurement is wrong, perform the steps outlined in the high–drive protection test procedure of the RF power control troubleshooting chart.

3.5.2 15–Watt Amplifier

(1) Use the standard test setup as described in Section 2.1.

(2) Verify that the radio is terminated in a 50–ohm load. Set the power supply voltage to 13.6 V. Adjust the power output to 17–watts.

(3) Measure the collector voltage of Q952. It should be greater than 1.0 V. With radio de–keyed, disconnect P951. Re–key the radio and remeasure the collector voltage of Q952. The voltage measurement should now be less than 0.1 V if the high–drive protection circuit is functioning properly. If the voltage measurement is wrong, perform the steps outlined in the high–drive protection test procedure of the RF power control troubleshooting chart.

att

TYPICAL METER READINGS ASSOCIATED WITH DIFFERENT POWER OUTPUT LEVELS

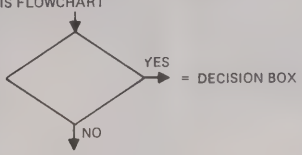
POWER OUTPUT (WATTS)	POWER CONTROL VOLTAGES (V)	TOTAL RADIO CURRENT (A)	PA METERING SOCKET READINGS (IN MICROAMPS)					
			MS1	MS2	IPA1/MS3	IPA2/MS3	PD/MS3	FPA/MS3
5	2.44	3.3	4.0	0	27	11	22	12
10	2.55	3.8	6.0	0	36	11	22	13
15	2.61	4.3	10.0	0	37	12	23	14
17	2.64	4.6	12.0	0	37	13	23	14

att

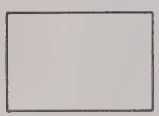
TYPICAL METER READINGS ASSOCIATED WITH DIFFERENT POWER OUTPUT LEVELS

POWER OUTPUT (WATTS)	POWER CONTROL VOLTAGES (V)	TOTAL RADIO CURRENT (A)	P.A. METERING SOCKET READINGS (IN MICROAMPS)						
			MS1	MS2	IPA1/MS3	IPA2/MS3	PD/MS3	DR/MS3	FPA/MS3
5	2.44	3.7	4.0	0	27	11	16	10	13
10	2.55	5.0	6.0	0	36	11	17	10	15
15	2.61	6.2	10.0	0	37	12	17	11	16
20	2.64	7.0	12.0	0	37	13	17	13	17
30	2.72	8.5	15.0	0	37	13.5	18	15	19
38	2.80	9.6	18.0	0	37	14	18	16	22

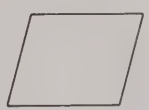
SYMBOLS AND ABBREVIATIONS USED IN THIS FLOWCHART



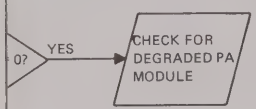
= DECISION BOX

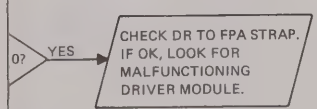


= ACTION TO BE TAKEN



= POSSIBLE LOCATION OF FAULT. DEFECTIVE COMPONENTS TO BE REPLACED.





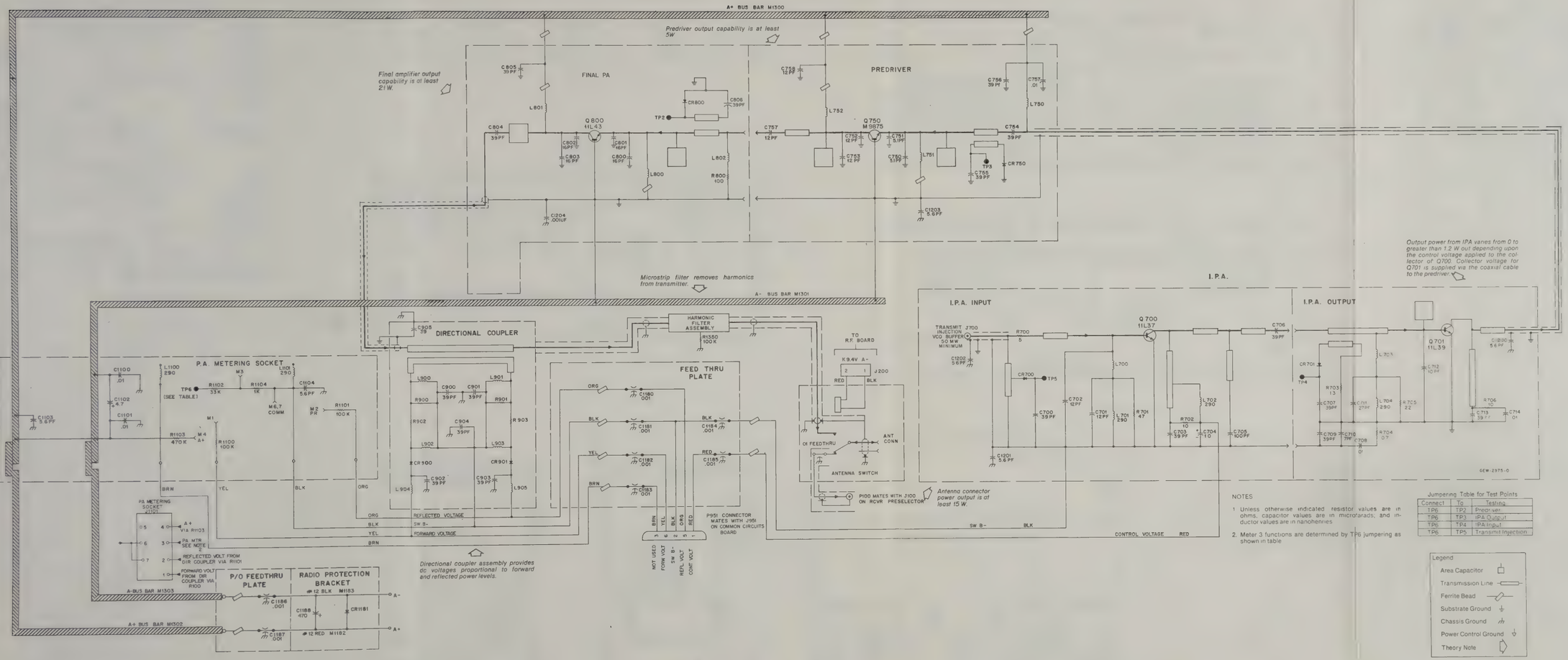
P.O. POWER OUTPUT
P.A. POWER AMPLIFIER
FPA FINAL POWER AMPLIFIER
IPA INTERMEDIATE POWER AMPLIFIER
IPA1 INTERMEDIATE POWER AMPLIFIER NO. 1
IPA2 INTERMEDIATE POWER AMPLIFIER NO. 2
PD PREDRIVER
DR DRIVER
CCB COMMON CIRCUIT BOARD
MS3 PIN NO. 3 OF THE METERING SOCKET

IPA1/MS3 PIN NO. 3 OF METERING SOCKET ASSOCIATED WITH INTERMEDIATE P.A. NO. 1. THE METERING SOCKET IS LOCATED ON P.A. BOARD. OTHERS ARE IPA2/MS3, FPA/MS3, PD/MS3, DR/MS3.

CCB/MS3 PIN NO. 3 OF METERING SOCKET LOCATED ON THE COMMON CIRCUITS BOARD.

GT GREATER THAN. USED FOR COMPARISON.
GE GREATER THAN OR EQUAL. USED FOR COMPARISON.
LT LESS THAN. USED FOR COMPARISON.
LE LESS THAN OR EQUAL. USED FOR COMPARISON.

Power Amplifier
Troubleshooting Chart
PW-3349-A
5/13/87



NOTES

1. Unless otherwise indicated resistor values are in ohms, capacitor values are in microfarads, and inductor values are in nanohenries.
2. Meter 3 functions are determined by TP6 jumpering as shown in table.

Jumpering Table for Test Points

Connect	To	Testing
TP6	TP2	Predriver
TP6	TP3	IPA Output
TP6	TP4	IPA Input
TP6	TP5	Transmit Injection

Legend

- Area Capacitor
- Transmission Line
- Ferrite Bead
- Substrate Ground
- Chassis Ground
- Power Control Ground
- Theory Note

Schematic, Circuit Board Diagrams, and Parts List for 15W Power Amplifier
PW–2635–C
(Sheet 2 of 2)
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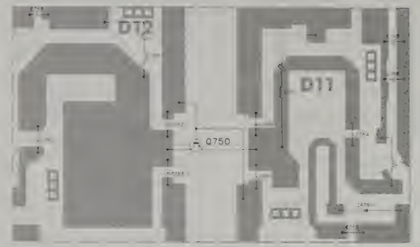
PREDRIVER



SHOWN FROM COMPONENT SIDE

TRN8853A Predriver — MXW-3375-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C750,751	21-11078B06	5.1 pF, ± .25 pF, 100V
C752,753	21-11078B15	12 pF, ±5%, 100V
C754-756	21-13740A43	39 pF, ±5%, 50V
C757	21-11078B13	12 pF, ±5%, 100V
C758	21-13740A31	12 pF, ±5%, 50V
C759	21-13741M45	.01 uF, ±10%, 50V
coil, RF		
L750	24-80091G16	airwound, 11 turns
L751,752	24-80089G03	ferrite, 3 turns
transistor (see note):		
Q750	48-00869875	NPN
non-referenced items		
	29-83208M01	lug
	42-80164B01	substrate retainer
	42-80165B02	substrate retainer clip
	64-80202X01	ground strap

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8858 Metering Board — MXW-3372-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C1100,1101	08-84637L25	.01 uF, ±10%, 400V
C1102	23-13749D71	4.7 uF, ±20%, 35V, tantalum
C1103,1104	21-83406D64	5.6 pF, ±.25 pF, 500V
connector receptacle		
J1101	09-84207B01	7 contact
coil, RF		
L1100,1101	24-82733H28	.22uH yellow
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated):		
R1100,1101	06-11009C97	100k
R1102	06-11009C85	33k
R1103	06-11009D14	470k
R1104	06-11009C49	1k
transformer		
T76	28-84528R21	1 pin circuit board

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

Schematic, Circuit Board Diagrams, and Parts Lists for 35W Power Amplifier

PW-3352-B

(Sheet 1 of 2)

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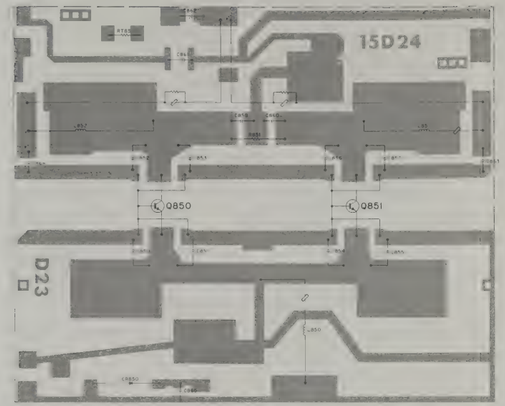
FINAL PA



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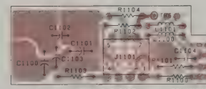
PA METERING BOARD



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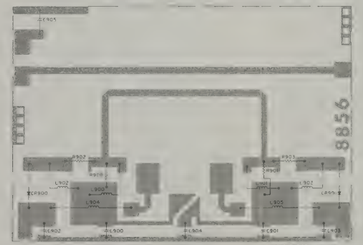
COMPONENT SIDE® 80- GW- 3355- O
SOLDER SIDE 80- GW- 3356- O
CL- GW-3357-D

DIRECTIONAL COUPLER



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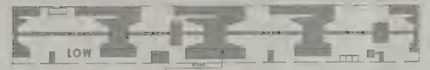
HARMONIC FILTER



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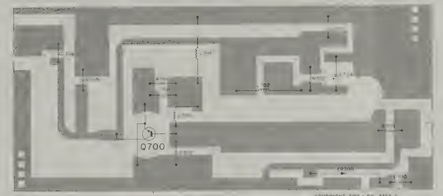
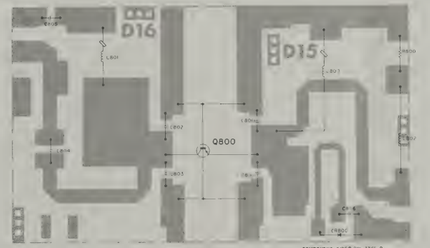
IPA INPUT



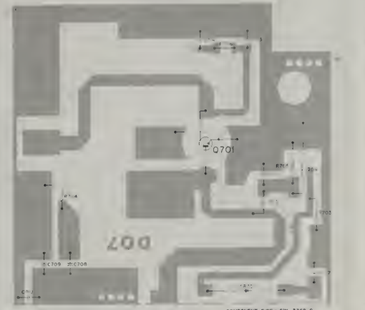
SHOWN FROM COMPONENT SIDE

DRIVER



SHOWN FROM COMPONENT SIDE

IPA OUTPUT



SHOWN FROM COMPONENT SIDE

parts list

TRN8857B Bus Wiring Kit (See note) — MXW-3371-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C1188	23-82361R14	470 uF, -10, +100%, 20V, electrolytic
diode		
CR1181	48-80153A01	silicon pellet
non-referenced items		
	01-80291K03	bus boss assembly
	37-09132251	black heatshrink tubing
	29-83857M01	single contact terminal, 2 used
	15-83499M01	black heatshrink tubing
	39-83495M02	bus boss contact (right)
	39-83496M02	bus boss contact (left)
	42-10217A02	nylon tie strap
	30-00858552	12 strand wire (black)
	30-00858553	12 strand wire (red)

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

HKN4155A 35 Watt Cable — MXW-6690-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector, plug		
P951	01-80724D23	cable & connector assembly includes
	15-84301K04	housing, 6-contact
	29-84300X01	plug, polarizing key
	39-82717M01	contact
impedance network		
Z850,851	01-80726D09	bead & resistor assembly includes
	05-11009C01	10 ohm resistor, 2 used
	76-84068B01	ferrite bead, 2 used
mechanical parts		
	01-80134N02	bus wire assembly
	42-10217A02	tie strap, 2 used
	42-83674M01	bus retainer
	42-83674M02	bus retainer
	42-83674M04	bus retainer
	42-83927M01	bus retainer
	76-83468K01	ferrite bead, 2 used
	30-83794C01	coax cable, white, 2 used
	30-80120B01	bottom bus wire, positive
	30-80121B01	bottom bus wire, negative
	30-80136B01	top bus wire, positive
	30-80137B01	top bus wire, negative

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TRN8856A Directional Coupler — MXW-3375-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C900-904	21-13740A43	39 pF, ±10%, 50V
C905	21-11078B32	39 pF, ±5%, 100V
diode (see note)		
CR900,901	48-84616A01	hot carrier
coil, RF		
L900,901	24-84331M47	airwound, 7 turns
L902,903	24-80091G16	airwound, 11 turns
non-referenced items		
	29-83208M01	lug
	D783481M01	directional coupler frame

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only

TRN8853A Driver Module — MXW-3376-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C800,801	21-11078B06	5.1 pF, ± .25 pF, 100V
C802,803	21-11078B15	12 pF, ±5%, 100V
C804	21-11078B32	39 pF, ±5%, 100V
C805	21-13740A39	27 pF, ±5%, 50V
C806	21-13740A43	39 pF, ±5%, 50V
coil, RF		
L800,801	24-80089G03	ferrite, 3 turns
L800	24-80089G02	airwound, 3 turns
transistor (see note)		
Q800	48-00869876	NPN
non-referenced items		
	29-83208M01	lug
	42-80164B01	substrate retainer
	42-80165B02	substrate retainer clip
	64-80202X01	ground strap

6 30 89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only

TRN8851A Intermediate Power Amplifier — MXW-3374-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C700	21-13740A43	39 pF, ±10%, 50V
C701	21-13740A31	12 pF, ±5%, 50V
C702	21-84673H75	7 pF, ± 25 pF, 50V
C703	21-13740A43	39 pF, ±10%, 50V
C704	23-84677D06	1 uF, ±10%, 20V, tantalum
C705	21-13740A53	100 pF, ±5%, 50V
C706,707	21-13740A43	39 pF, ±10%, 50V
C708	21-13741M45	.01 uF, ±10%, 50V, tantalum
C709	21-13740A43	39 pF, ±10%, 50V
C710	21-84673H75	7 pF, ± 25 pF, 50V
C711	21-13740A39	27 pF, ±5%, 50V
C712	21-13740A29	10 pF, ±5%, 50V
C713	21-13740A43	39 pF, ±10%, 50V
C714	21-13741M45	.01 uF, ±10%, 50V, tantalum
diode (see note)		
CR700,701	48-84616A11	hot carrier
connector receptacle		
J700	01-80719D61	phono plug assembly
coil, RF		
L700	24-80091G20	airwound
L701,702	24-82733H40	.25 uH, yellow black
L703	24-80091G20	airwound
L704	24-82733H40	.25 uH, yellow black
transistor (see note)		
Q700	48-80225C08	NPN
Q701	48-84411L39	NPN
non-referenced items		
	02-00007003	nut (8-32 x 5/16 x 1/8), 8 used
	03-10281A10	nylon rivet
	42-10217A02	nylon tie wrap
	01-80719D61	IPA assembly plate
	09-83577M01	connector
	29-80177B01	coax terminal
	37-00132562	heatshrink tubing
	01-80713D98	IPA black input wire assembly
	01-80709D99	IPA red input wire assembly
	29-84706D06	chain terminal, 2 used
	84-83107M01	circuit board output substrate
	84-83105M01	circuit board input substrate

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only

TRN8858A PA Hardware — MXW-3375-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C1205-1206	21-83406D64	5.6 pF, ± .25 pF, 500V
	21-80067A62	82 uF, ±5%, 200V
impedance network		
Z852	01-80739T33	coax assembly includes
	30-83361G01	coax
	76-83466K01	ferrite bead, 2 used
mechanical parts		
	76-83466K01	ferrite bead 2 used
	02-80006A01	nut spanner
	03-00132127	tapping screw 6-20X3.4
	03-10911A11	machine screw M3 x .5 x 8 8 used
	03-10911A12	machine screw M3 x 0.5 x 10 .3 used
	03-10943M16	tapping screw TT3.5 x 0.6 x 8 .7 used
	03-10943M15	tapping screw TT3.5 x 0 6 x 6 .6 used
	04-00114522	lock washer
	04-82470N01	mounting washer, 3 used
	04-84180C01	shoulder washer, 3 used
	14-83901M01	lower bus insulator
	15-80108B02	housing
	15-80124B01	harmonic filter cover
	26-80189B01	PA cover
	29-84093M01	solder lug, 6 used
	32-83896M01	RF gasket
	39-80203C02	finger contact
	42-10128A18	retaining ring
	42-10217A02	tie strap, 4 used
	42-80013A01	coax clip
	42-80167B01	bus top clip
	42-80982M01	cable clip
	42-84510M04	PA strap 2 used
	76-84068B04	ferrite bead, 11 used

6/30/89

note: For best performance, order diodes transistors, and integrated circuit devices by Motorola part number

HLN4217A Feedthru Plate — MXW-6689-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C1180-1187	01-80064L04	feedthru plate assembly includes
	21-82612H03	.001 uF, +100, -0%, 500V
	84-83755H01	solder washer (8 used)
	64-80122B01	feedthru pate

6/30/89

TRN8854A Final Amplifier — MXW-33

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated):		
C850-857	21-11078B15	12 pF, ±5%, 100V
C859-861	21-11078B32	39 pF, ±5%, 100V
C863,864	21-13740A31	12 pF, ±5%, 50V
C865	21-13740A43	39 pF, ±10%, 50V
diode (see note)		
CR850	48-84616A11	hot carrier
coil, RF		
L850-852	24-80089G01	ferrite, 3 turns
transistor (see note)		
Q850 851	48-84411L43	NPN
thermistor		
RT850	06-82696B01	thermistor
resistor, fixed, ohm, ±5%, 1-4 watt (unless otherwise stated):		
R850	06-11009C01	10
non-referenced items		
	42-80163B02	connecting strap
	42-84417K01	substrate holder

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only

TRN8850A Harmonic Filter Module — MXW-3378-A

REFERENCE SYMBOL	MOTOROLA PART NO	DESCRIPTION
R1350	06-11009C97	100k, ±5%, 1/4W
M1	07-80123B01	harmonic filter frame

5 10 89

mediate Power Amplifier — MXW–3374–B

	MOTOROLA PART NO.	DESCRIPTION
(unless otherwise stated)		
	21–13740A43	39 pF, ±10%, 50V
	21–13740A31	12 pF, ±5%, 50V
	21–84873H75	7 pF, ±.25 pF, 50V
	21–13740A43	39 pF, ±10%, 50V
	23–84677D06	1 uF, ±10%, 20V, tantalum
	21–13740A55	100 pF, ±5%, 50V
	21–13740A43	39 pF, ±10%, 50V
	21–13741M45	.01 uF, ±10%, 50V, tantalum
	21–13740A43	39 pF, ±10%, 50V
	21–84873H75	7 pF, ±.25 pF, 50V
	21–13740A39	27 pF, ±5%, 50V
	21–13740A29	10 pF, ±5%, 50V
	21–13740A43	39 pF, ±10%, 50V
	21–13741M45	.01 uF, ±10%, 50V, tantalum
	48–84616A11	hot carrier
otacle		
	01–80719D61	phono plug assembly
	24–80091G20	airwound
	24–82723H40	.29 uH, yellow black
	24–80091G20	airwound
	24–82723H40	.29 uH, yellow black
note)		
	48–80225C08	NPN
	48–84411L39	NPN
	non–referenced items	
	02–00007003	nut (8–32 x 5/16 x 1/8), 8 used
	05–10281A10	nylon rivet
	42–10217A02	nylon tie wrap
	01–80719D61	IPA assembly plate
	09–83577M01	connector
	29–80177B01	coax terminal
	37–00132562	heatshrink tubing
	01–80719D98	IPA black input wire assembly
	01–80719D99	IPA red input wire assembly
	29–84706E06	chain terminal, 2 used
	84–83107M01	circuit board, output substrate
	84–83105M01	circuit board, input substrate

6/30/89

r of this kit is not recommended. It should be replaced in its entirety. Parts erence only.

l Power Amplifier Module — MXW-2651-O

MOTOROLA PART NO.	DESCRIPTION
	capacitor, pF, fixed ±5%, 50V unless otherwise stated
21-84736E08	16
21-84736E12	39
21-84873H63	39
	coil
24-80089G02	3 turns
24-80089G03	ferrite bead, 3 turns
	resistor, Ω, fixed
06-11041C41	100 ±5%, ⅛W
	non-referenced items
29-83208M01	solder lug, 3 used
42-80164B01	substrate retainer
42-80165B02	substrate retainer clip, 2 used

air of this kit is not recommended. It should be replaced in its entirety. These for reference purposes only.

–Amplifier — MXW–3343–B

	MOTOROLA PART NO.	DESCRIPTION
d (unless otherwise stated)		
	21–13741M45	.01 uF, ±10%, 50V
	21–13740A44	43 pF, ±5%, 50V
	21–13740A27	8.2 pF, ±5%, 50V
	21–11078A09	1.8 pF,±.25 pF, 100V
	21–13740A44	43 pF, ±5%, 50V
	21–13741M45	.01 uF, ±10%, 50V
	21–13740A31	12 pF, ±5%, 50V
	——	non–replacable parts
e)		
	48–80010E02	pin
	24–82723H40	.29 uH, yellow black
note)		
	48–00869870	NPN
	48–84939C23	PNP

6/30/89

performance, order diodes, transistors, and integrated circuit devices by umber.

TRN8853A Driver Module — MXW–3376–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C800,801	21–11078B06	5.1 pF, ±.25 pF, 100V
C802,803	21–11078B15	12 pF, ±5%, 100V
C804	21–11078B32	39 pF, ±5%, 100V
C805	21–13740A39	27 pF, ±5%, 50V
C806	21–13740A43	39 pF, ±5%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L800,801	24–80089G03	ferrite, 3 turns
L802	24–80089G02	airwound, 3 turns
transistor (see note)		
Q800	48–00869876	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R800	06–11041C17	10
	non–referenced items	
	29–83208M01	lug, 2 used
	42–80164B01	substrate retainer
	42–80165B02	substrate retainer clip, 2 used
	64–80202K01	ground strap
	84–83115M01	circuit board substrate, input
	84–83116M01	circuit board substrate, output

6/30/89

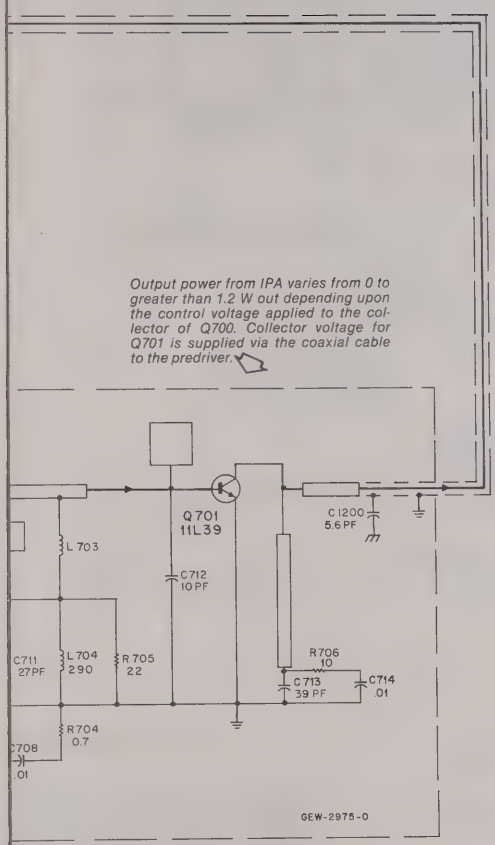
note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8854A Final Amplifier — MXW–3377–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C850–857	21–11078B15	12 pF, ±5%, 100V
C859–861	21–11078B32	39 pF, ±5%, 100V
C862	21–13741M45	.01 uF, ±10%, 50V
C863,864	21–13740A31	12 pF, ±10%, 50V
C865	21–13740A43	39 pF, ±10%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L850–852	24–80089G01	ferrite, 3 turns
transistor (see note)		
Q850,851	48–84411L43	NPN
thermistor		
RT850	06–82696B01	thermistor
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R851	06–11009C01	10
	non–referenced items	
	42–80163B03	connecting strap
	42–84417K01	substrate holder
	84–83117M01	circuit board substrate, input
	84–83118M01	circuit board substrate, output

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.



values are in farads; and in-

P6 jumpering as

Jumpering Table for Test Points

Connect	To	Testing
TP6	TP2	Predriver
TP6	TP3	IPA Output
TP6	TP4	IPA Input
TP6	TP5	Transmit Injection

Legend:

- Area Capacitor
- Transmission Line
- Ferrite Bead
- Substrate Ground
- Chassis Ground
- Power Control Ground
- Theory Note

Schematic, Circuit Board Diagrams, and Parts List for 15W Power Amplifier
PW–2635–C
(Sheet 2 of 2)
6/30/89

ediate Power Amplifier — MXW–3374–B

MOTOROLA PART NO.	DESCRIPTION
(unless otherwise stated)	
21–13740A43	39 pF, ±10%, 50V
21–13740A31	12 pF, ±5%, 50V
21–84873H75	7 pF, ±.25 pF, 50V
21–13740A43	39 pF, ±10%, 50V
23–84677D06	1 uF, ±10%, 20V, tantalum
21–13740A55	100 pF, ±5%, 50V
21–13740A43	39 pF, ±10%, 50V
21–13741M45	.01 uF, ±10%, 50V, tantalum
21–13740A43	39 pF, ±10%, 50V
21–84873H75	7 pF, ±.25 pF, 50V
21–13740A39	27 pF, ±5%, 50V
21–13740A29	10 pF, ±5%, 50V
21–13740A43	39 pF, ±10%, 50V
21–13741M45	.01 uF, ±10%, 50V, tantalum
48–84616A11	hot carrier
tacle	
01–80719D61	phono plug assembly
24–80091G20	airwound
24–82723H40	.29 uH, yellow black
24–80091G20	airwound
24–82723H40	.29 uH, yellow black
ote)	
48–80225C08	NPN
48–84411L39	NPN
non–referenced items	
02–00007003	nut (8–32 x 5/16 x 1/8), 8 used
05–10281A10	nylon rivet
42–10217A02	nylon tie wrap
01–80719D61	IPA assembly plate
09–83577M01	connector
29–80177B01	coax terminal
37–00132562	heatshrink tubing
01–80719D98	IPA black input wire assembly
01–80719D99	IPA red input wire assembly
29–84706E06	chain terminal, 2 used
84–83107M01	circuit board, output substrate
84–83105M01	circuit board, input substrate

6/30/89

of this kit is not recommended. It should be replaced in its entirety. Parts rence only.

Power Amplifier Module — MXW-2651-O

MOTOROLA PART NO.	DESCRIPTION
	capacitor, pF, fixed ±5%, 50V unless otherwise stated
21-84736E08	16
21-84736E12	39
21-84873H63	39
	coil
24-80089G02	3 turns
24-80089G03	ferrite bead, 3 turns
	resistor, Ω, fixed
06-11041C41	100 ±5%, ⅛W
non-referenced items	
29-83208M01	solder lug, 3 used
42-80164B01	substrate retainer
42-80165B02	substrate retainer clip, 2 used

ir of this kit is not recommended. It should be replaced in its entirety. These for reference purposes only.

-Amplifier — MXW–3343–B

MOTOROLA PART NO.	DESCRIPTION
d (unless otherwise stated)	
21–13741M45	.01 uF, ±10%, 50V
21–13740A44	43 pF, ±5%, 50V
21–13740A27	8.2 pF, ±5%, 50V
21–11078A09	1.8 pF,±.25 pF, 100V
21–13740A44	43 pF, ±5%, 50V
21–13741M45	.01 uF, ±10%, 50V
21–13740A31	12 pF, ±5%, 50V
——	non–replacable parts
e)	
48–80010E02	pin
24–82723H40	.29 uH, yellow black
note)	
48–00869870	NPN
48–84939C23	PNP

6/30/89

performance, order diodes, transistors, and integrated circuit devices by umber.

TRN8853A Driver Module — MXW–3376–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C800,801	21–11078B06	5.1 pF, ±.25 pF, 100V
C802,803	21–11078B15	12 pF, ±5%, 100V
C804	21–11078B32	39 pF, ±5%, 100V
C805	21–13740A39	27 pF, ±5%, 50V
C806	21–13740A43	39 pF, ±5%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L800,801	24–80089G03	ferrite, 3 turns
L802	24–80089G02	airwound, 3 turns
transistor (see note)		
Q800	48–00869876	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R800	06–11041C17	10
non–referenced items		
	29–83208M01	lug, 2 used
	42–80164B01	substrate retainer
	42–80165B02	substrate retainer clip, 2 used
	64–80202K01	ground strap
	84–83115M01	circuit board substrate, input
	84–83116M01	circuit board substrate, output

6/30/89

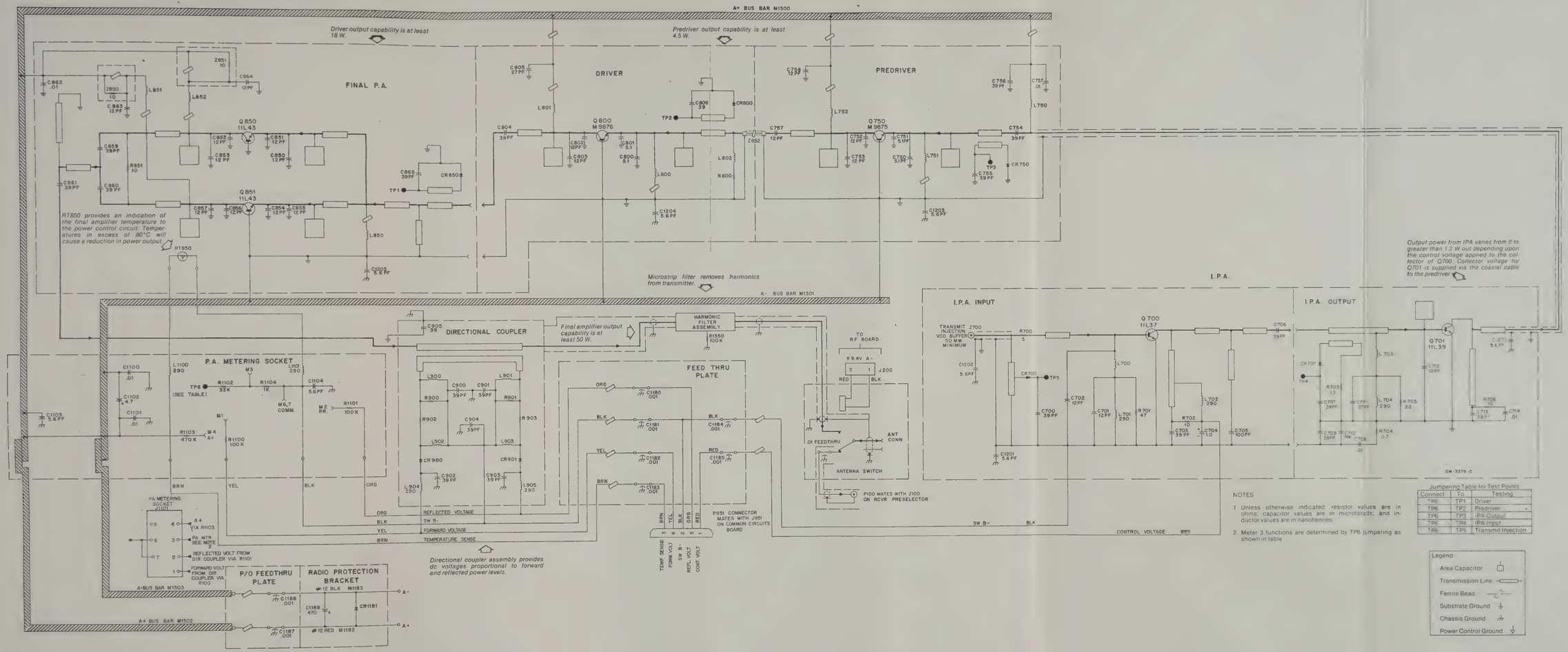
note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8854A Final Amplifier — MXW–3377–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C850–857	21–11078B15	12 pF, ±5%, 100V
C859–861	21–11078B32	39 pF, ±5%, 100V
C862	21–13741M45	.01 uF, ±10%, 50V
C863,864	21–13740A31	12 pF, ±10%, 50V
C865	21–13740A43	39 pF, ±10%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L850–852	24–80089G01	ferrite, 3 turns
transistor (see note)		
Q850,851	48–84411L43	NPN
thermistor		
RT850	06–82696B01	thermistor
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R851	06–11009C01	10
non–referenced items		
	42–80163B03	connecting strap
	42–84417K01	substrate holder
	84–83117M01	circuit board substrate, input
	84–83118M01	circuit board substrate, output

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.



NOTES

1. Unless otherwise indicated: resistor values are in ohms; capacitor values are in microfarads; and inductor values are in nanohenries.
2. Meter 3 functions are determined by TP6 jumpering as shown in table.

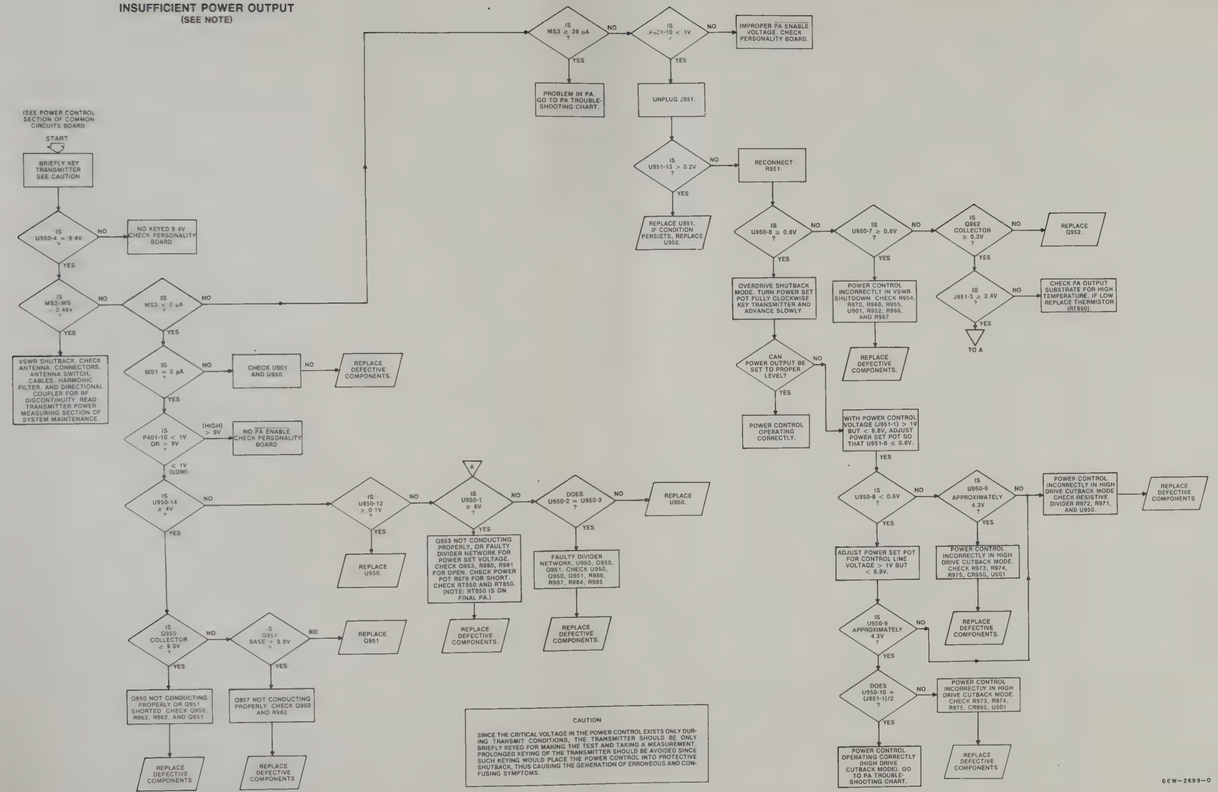
Jumpering Table for Test Points

Connect	To	Testing
*P6	TP1	Driver
TP6	TP2	Predriver
TP6	TP3	IPA Output
TP6	TP4	IPA Input
TP6	TP5	Transmit Injection

Legend:
- Area Capacitor
- Transmission Line
- Ferrite Bead
- Substrate Ground
- Chassis Ground
- Power Control Ground

Schematic, Circuit Board Diagrams, and Parts Lists for 35W Power Amplifier
PW–3352–B
(Sheet 2 of 2)
6/30/89

INSUFFICIENT POWER OUTPUT
(SEE NOTE)

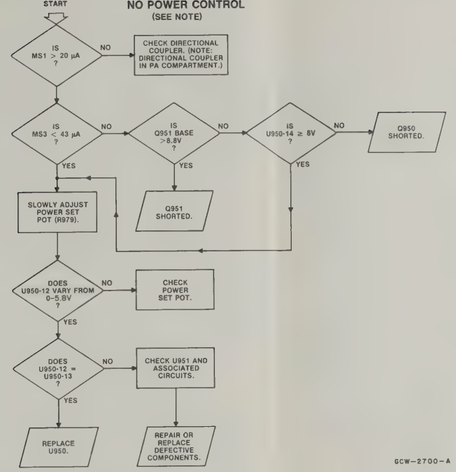


CAUTION

SINCE THE CRITICAL VOLTAGE IN THE POWER CONTROL EXISTS ONLY DURING TRANSMIT CONDITIONS, THE TRANSMITTER SHOULD BE ONLY BRIEFLY KEYED FOR MAKING THE TEST AND TAKING A MEASUREMENT. PROLONGED KEYING OF THE TRANSMITTER SHOULD BE AVOIDED SINCE SUCH KEYING WOULD PLACE THE POWER CONTROL INTO PROTECTIVE SHUTBACK, THUS CAUSING THE GENERATION OF ERRONEOUS AND CONFUSING SYMPTOMS.

GCW-2699-0

NO POWER CONTROL
(SEE NOTE)



NOTE

WHEN THE POWER AMPLIFIER FAILS, IT IS VERY PROBABLE THAT THE POWER CONTROL PROTECTION FUNCTIONS ARE NOT OPERATING PROPERLY. CONSEQUENTLY, IT IS RECOMMENDED THAT THE FOLLOWING THREE CHECKS ILLUSTRATED ON THE FLOW CHART BE PERFORMED WHENEVER THE POWER AMPLIFIER FAILS.

(A) VSWR PROTECTION

(B) LOW-LINE CUTBACK

(C) HIGH-DRIVE PROTECTION

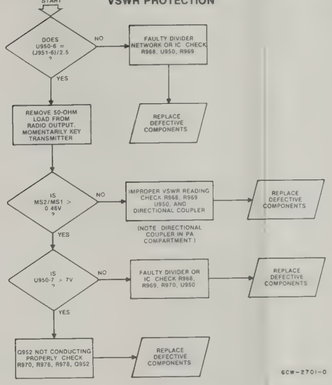
IT IS ALSO RECOMMENDED THAT THESE CHECKS BE PERFORMED AFTER COMPLETING EITHER OF THE TWO OTHER CHECKS, INSUFFICIENT POWER OUTPUT AND LACK OF POWER CONTROL.

NOTE

ALL VOLTAGE VALUES ARE REFERENCED TO A-.

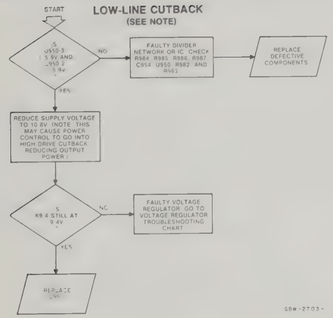
GCW-2700-A

VSWR PROTECTION



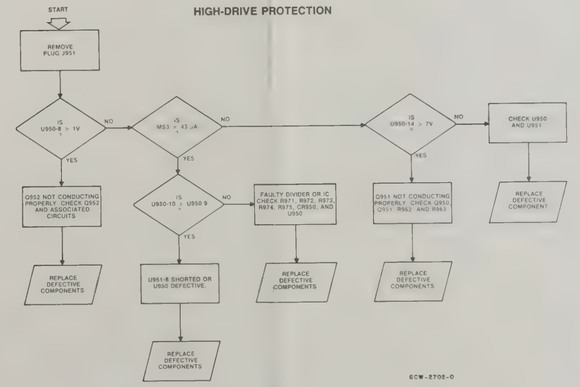
GCW-2701-0

LOW-LINE CUTBACK
(SEE NOTE)



GCW-2703-

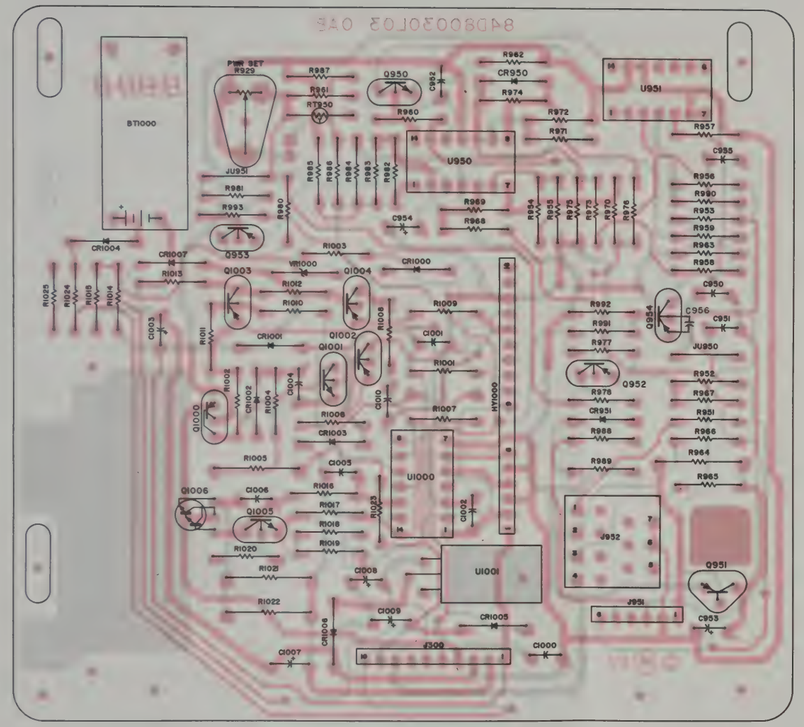
HIGH-DRIVE PROTECTION



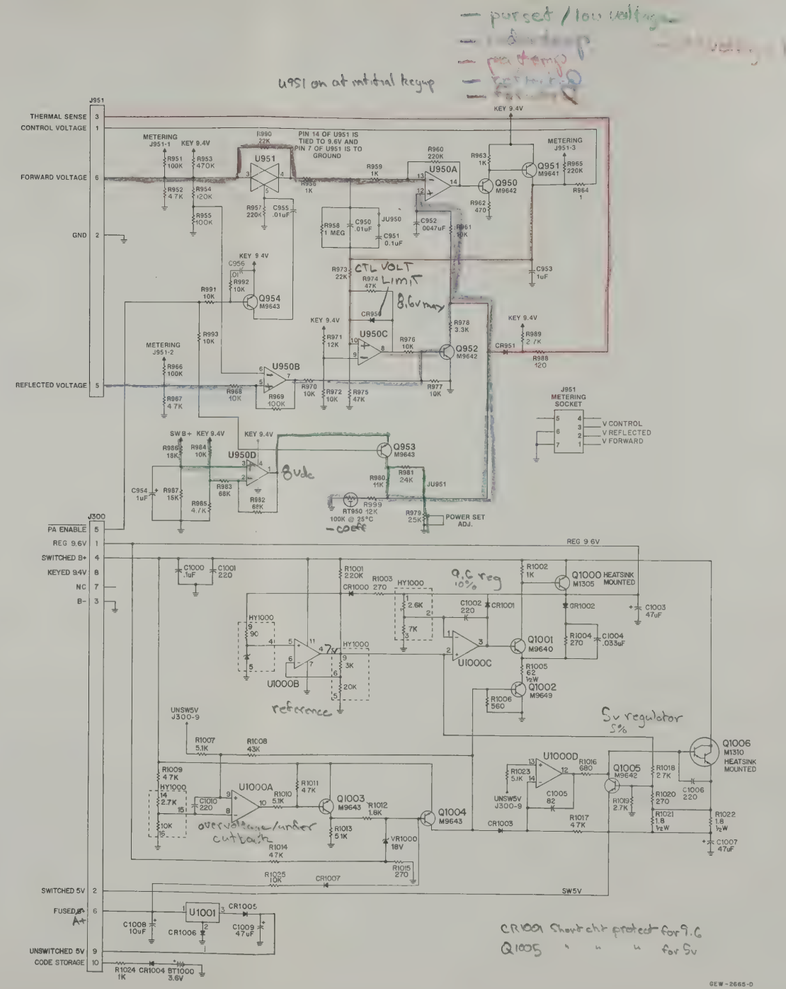
GCW-2702-0

1/25/89

800MHz COMMON CIRCUITS BOARD



Schematic, Circuit Board Diagram, and
Parts List for the HLN4971C
Common Circuits Board (800 MHz)
PW–2766–D
7/24/89



parts list

HLN4971C Common Circuits Board (800 MHz) MXW-2669-E

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C950	08–11051A07	.01 uF, ±5%, 63V
C951	08–11051A13	.1 uF, ±5%, 63V
C952	08–11051A05	.0047 uF, ±5%, 63V
C953,954	23–13749D51	1 uF, ±10%, 35V, tantalum
C955	08–11051A07	.01 uF, ±5%, 63V
C956	21–11015A07	.01 uF, +80, –20%
C1000	08–11051A13	.1 uF, ±5%, 63V
C1001,1002	21–11015B05	220 pF, ±10%, 100V
C1003	23–11019A39	47 uF, ±20%, 16V, electrolytic
C1004	08–11051A10	.033 uF, ±5%, 63V
C1005	21–11014B47	82 pF, ±5%, 100V
C1006	21–11015B05	220 pF, ±10%, 100V
C1007	23–84538G06	47 uF, ±20%, 20V, tantalum
C1008	23–11048C11	10 uF, ±20%, 35V, electrolytic
C1009	23–84538G29	47 uF, ±20%, 10V, tantalum
C1010	21–11015B05	220 pF, ±10%, 100V
diode (see note)		
CR950,951	48–83654H01	silicon
CR1000–1007	48–83654H01	silicon
hybrid (see note)		
HY1000	01–80715D03	regulator assembly
connector receptacle		
J300	30–80263K01	10 conductor cable assembly
J951	28–84647L04	6 pin
J952	09–84207B01	7 contact
jumper		
JU950,951	06–11009B23	0 ohm
transistor (see note)		
Q950	48–00869648	NPN
Q951	48–00869641	PNP
Q952	48–00869642	NPN
Q953,954	48–00869643	PNP
Q1000	48–84413L05	PNP
Q1001	48–00869640	NPN
Q1002	48–00869649	PNP
Q1003,1004	48–00869643	PNP
Q1005	48–00869642	NPN
Q1006	48–84413L10	NPN, Darlington
thermistor		
RT950	06–80286D01	100k, ±10%
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R951	06–11009A97	100k
R952	06–11009A65	4.7k
R953	06–11009B14	470k
R954	06–11009A99	120k
R955	06–11009A97	100k
R956	06–11009A49	1k
R957	06–11009B06	220k
R958	06–11009B22	1MEG
R959	06–11009A49	1k
R960	06–11009B06	220k
R961	06–11009A73	10k
R962	06–11009A41	470
R963	06–11009A49	1k
R964	06–80037G01	1, 1/2W
R965	06–11009B06	220k
R966	06–11009A97	100k
R967	06–11009A65	4.7k
R968	06–11009A73	10k
R969	06–11009A97	100k
R970	06–11009A73	10k
R971	06–11009A75	12k
R972	06–11009A73	10k
R973	06–11009A81	22k
R974,975	06–11009A89	47k
R976,977	06–11009A73	10k
R978	06–11009A61	3.3k
R979	18–80087E01	25k, potentiometer
R980	06–11009A74	11k
R981	06–11009A82	24k
R982,983	06–11009A93	68k
R984	06–11009A73	10k
R985	06–11009A65	4.7k
R986	06–11009A79	18k
R987	06–11009A77	15k
R988	06–11009A27	120
R989	06–11009A58	2.4k
R990	06–11009A81	22k
R991–993	06–11009A73	10k
R999	06–11009A75	12k
R1001	06–11009B06	220k
R1002	06–11009A49	1k
R1003,1004	06–11009A35	270
R1005	06–11045A20	62, 1/2W
R1006	06–11009A43	560
R1007	06–11009A66	5.1k
R1008	06–11009A88	43k
R1009	06–11009A65	4.7k
R1010	06–11009A66	5.1k
R1011	06–11009A65	4.7k
R1012	06–11009A55	1.8k
R1013	06–11009A66	5.1k
R1014	06–11009A65	4.7k
R1015	06–11009A35	270
R1016	06–11009A45	680
R1017	06–11009A65	4.7k

MXW-2669-E (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1018,1019	06–11009A59	2.7k
R1020	06–11009A35	270
R1021,1022	06–80037G07	1.8, 1/2W
R1023	06–11009A66	5.1k
R1024	06–11009A49	1k
R1025	06–11009A73	10k
integrated circuit (see note)		
U950	51–83222M10	quad opamp
U951	51–84887K04	quad switch
U1000	51–80067C06	quad opamp
U1001	51–80068C02	voltage regulator
voltage regulator (see note)		
VR1000	48–82256C53	18V, zener
mechanical parts		
	03–10911A11	machine screw (M3 x 0.5 x 8)
	04–84180C01	nylon shoulder washer
	14–83820M02	heat conductive insulator
	26–84835M04	heat sink regulator
	75–80171L01	hybrid pad
	54–80072G01	label
	03–10943M10	tapping screw (TT3x 0.5 x 8)

7/24/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

TRN8856A Directional Coupler — MXW–3373–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C900–904	21–13740A43	39 pF, ±10%, 50V
C905	21–11078B32	39 pF, ±5%, 100V
diode (see note)		
CR900,901	48–84616A01	hot carrier
coil, RF		
L900,901	24–84331M47	airwound, 7 turns
L902,903	24–80091G16	airwound, 11 turns
non–referenced items		
	29–83208M01	lug
	0783481M01	directional coupler frame

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8853A Driver Module — MXW–3376–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C800,801	21–11078B06	5.1 pF, ±.25 pF, 100V
C802,803	21–11078B15	12 pF, ±5%, 100V
C804	21–11078B32	39 pF, ±5%, 100V
C805	21–13740A39	27 pF, ±5%, 50V
C806	21–13740A43	39 pF, ±5%, 50V
coil, RF		
L800,801	24–80089G03	ferrite, 3 turns
L802	24–80089G02	airwound, 3 turns
transistor (see note)		
Q800	48–00869876	NPN
non–referenced items		
	29–83208M01	lug
	42–80164B01	substrate retainer
	42–80165B02	substrate retainer clip
	64–80202K01	ground strap

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8851A Intermediate Power Amplifier — MXW–3374–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C700	21–13740A43	39 pF, ±10%, 50V
C701	21–13740A31	12 pF, ±5%, 50V
C702	21–84873H75	7 pF, ±.25 pF, 50V
C703	21–13740A43	39 pF, ±10%, 50V
C704	23–84677D06	1 uF, ±10%, 20V, tantalum
C705	21–13740A55	100 pF, ±5%, 50V
C706,707	21–13740A43	39 pF, ±10%, 50V
C708	21–13741M45	.01 uF, ±10%, 50V, tantalum
C709	21–13740A43	39 pF, ±10%, 50V
C710	21–84873H75	7 pF, ±.25 pF, 50V
C711	21–13740A39	27 pF, ±5%, 50V
C712	21–13740A29	10 pF, ±5%, 50V
C713	21–13740A43	39 pF, ±10%, 50V
C714	21–13741M45	.01 uF, +10%, 50V, tantalum
diode (see note)		
CR700,701	48–84616A11	hot carrier
connector receptacle		
J700	01–80719D61	phono plug assembly
coil, RF		
L700	24–80091G20	airwound
L701,702	24–82723H40	.29 uH, yellow black
L703	24–80091G20	airwound
L704	24–82723H40	.29 uH, yellow black
transistor (see note)		
Q700	48–80225C08	NPN
Q701	48–84411L39	NPN
non–referenced items		
	02–00007003	nut (8–32 x 5/16 x 1/8), 8 used
	05–10281A10	nylon rivet
	42–10217A02	nylon tie wrap
	01–80719D61	IPA assembly plate
	09–83577M01	connector
	29–80177B01	coax terminal
	37–00132562	heatshrink tubing
	01–80719D98	IPA black input wire assembly
	01–80719D99	IPA red input wire assembly
	29–84706E06	chain terminal, 2 used
	84–83107M01	circuit board, output substrate
	84–83105M01	circuit board, input substrate

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8858A PA Hardware — MXW–3370–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C1200–1205	21–83406D64	5.6 pF, ±.25 pF, 500V
	21–80067A62	82 uF, ±5%, 200V
impedance network		
Z852	01–80739T33	coax assembly includes:
	30–83361G01	coax
	76–83466K01	ferrite bead, 2 used
mechanical parts		
	76–83466K01	ferrite bead, 2 used
	02–80006A01	nut spanner
	03–00132127	tapping screw 6–20X3/4
	03–10911A11	machine screw M3 x .5 x 8, 8 used
	03–10911A12	machine screw M3 x 0.5 x 10, 3 used
	03–10943M10	tapping screw TT3 x 0.5 x 8, 7 used
	03–10943M15	tapping screw TT3.5 x 0.6 x 8, 6 used
	04–00114522	lock washer
	04–82470N01	mounting washer, 3 used
	04–84180C01	shoulder washer, 3 used
	14–83901M01	lower bus insulator
	15–80105B02	housing
	15–80124B01	harmonic filter cover
	26–80169B01	PA cover
	29–84093M01	solder lug, 6 used
	32–83896M01	RF gasket
	39–80203C02	finger contact
	42–10128A18	retaining ring
	42–10217A02	tie strap, 4 used
	42–80013A01	coax clip
	42–80167B01	bus top clip
	42–83982M01	cable clip
	42–84510M04	PA strap, 2 used
	76–84069B04	ferrite bead, 11 used

9/1/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN4217A Feedthru Plate — MXW–6889–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	01–80064L04	feedthru plate assembly includes:
C1180–1187	21–82812H03	.001 uF, +100, –0%, 500V
	04–83755H01	solder washer (8 used)
	64–80122B01	feedthru palte

9/1/89

TRN8854A Final Amplifier — MXW–3377–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C850–857	21–11078B15	12 pF, ±5%, 100V
C859–861	21–11078B32	39 pF, ±5%, 100V
C863,864	21–13740A31	12 pF, ±10%, 50V
C865	21–13740A43	39 pF, ±10%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L850–852	24–80089G01	ferrite, 3 turns
transistor (see note)		
Q850,851	48–84411L43	NPN
thermistor		
RT850	06–82696B01	thermistor
resistor, fixed, ohm, +5%, 1/4 watt (unless otherwise stated)		
R850	06–11009C01	10
non–referenced items		
	42–80163B03	connecting strap
	42–84417K01	substrate holder

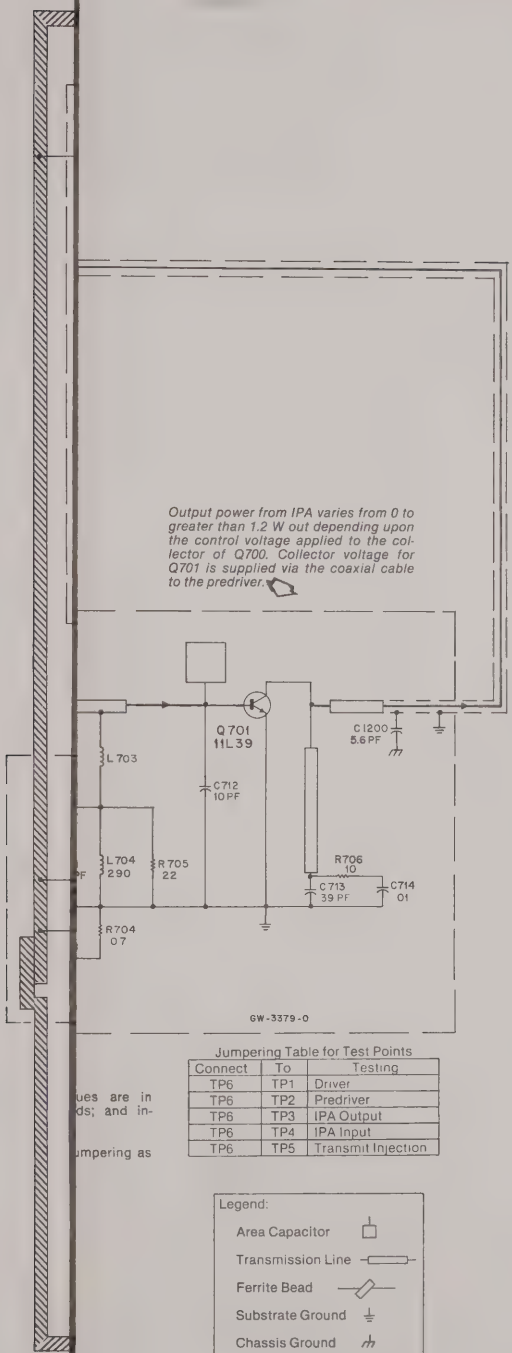
6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8850A Harmonic Filter Module — MXW–3378–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1350	06–11009C97	100k, ±5%, 1/4W
M1	07–80123B01	harmonic filter frame

5/10/88



Jumpering Table for Test Points

Connect	To	Testing
TP6	TP1	Driver
TP6	TP2	Predriver
TP6	TP3	IPA Output
TP6	TP4	IPA Input
TP6	TP5	Transmit Injection

ues are in
ds; and in-

umpering as

Legend:
- Area Capacitor
- Transmission Line
- Ferrite Bead
- Substrate Ground
- Chassis Ground
- Power Control Ground

Schematic, Circuit Board Diagrams, and
Parts Lists for 35W Power Amplifier
PW–3352–B
(Sheet 2 of 2)
6/30/89

TRN8856A Directional Coupler — MXW–3373–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C900–904	21–13740A43	39 pF, ±10%, 50V
C905	21–11078B32	39 pF, ±5%, 100V
diode (see note)		
CR900,901	48–84616A01	hot carrier
coil, RF		
L900,901	24–84331M47	airwound, 7 turns
L902,903	24–80091G16	airwound, 11 turns
non–referenced items		
	29–83208M01	lug
	0783481M01	directional coupler frame

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8853A Driver Module — MXW–3376–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C800,801	21–11078B06	5.1 pF, ±.25 pF, 100V
C802,803	21–11078B15	12 pF, ±5%, 100V
C804	21–11078B32	39 pF, ±5%, 100V
C805	21–13740A39	27 pF, ±5%, 50V
C806	21–13740A43	39 pF, ±5%, 50V
coil, RF		
L800,801	24–80089G03	ferrite, 3 turns
L802	24–80089G02	airwound, 3 turns
transistor (see note)		
Q800	48–00869876	NPN
non–referenced items		
	29–83208M01	lug
	42–80164B01	substrate retainer
	42–80165B02	substrate retainer clip
	64–80202K01	ground strap

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8851A Intermediate Power Amplifier — MXW–3374–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C700	21–13740A43	39 pF, ±10%, 50V
C701	21–13740A31	12 pF, ±5%, 50V
C702	21–84873H75	7 pF, ±.25 pF, 50V
C703	21–13740A43	39 pF, ±10%, 50V
C704	23–84677D06	1 uF, ±10%, 20V, tantalum
C705	21–13740A55	100 pF, ±5%, 50V
C706,707	21–13740A43	39 pF, ±10%, 50V
C708	21–13741M45	.01 uF, ±10%, 50V, tantalum
C709	21–13740A43	39 pF, ±10%, 50V
C710	21–84873H75	7 pF, ±.25 pF, 50V
C711	21–13740A39	27 pF, ±5%, 50V
C712	21–13740A29	10 pF, ±5%, 50V
C713	21–13740A43	39 pF, ±10%, 50V
C714	21–13741M45	.01 uF, ±10%, 50V, tantalum
diode (see note)		
CR700,701	48–84616A11	hot carrier
connector receptacle		
J700	01–80719D61	phono plug assembly
coil, RF		
L700	24–80091G20	airwound
L701,702	24–82723H40	.29 uH, yellow black
L703	24–80091G20	airwound
L704	24–82723H40	.29 uH, yellow black
transistor (see note)		
Q700	48–80225C08	NPN
Q701	48–84411L39	NPN
non–referenced items		
	02–00007003	nut (8–32 x 5/16 x 1/8), 8 used
	05–10281A10	nylon rivet
	42–10217A02	nylon tie wrap
	01–80719D61	IPA assembly plate
	09–83577M01	connector
	29–80177B01	coax terminal
	37–00132562	heatshrink tubing
	01–80719D98	IPA black input wire assembly
	01–80719D99	IPA red input wire assembly
	29–84706E06	chain terminal, 2 used
	84–83107M01	circuit board, output substrate
	84–83105M01	circuit board, input substrate

6/30/89

note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

TRN8858A PA Hardware — MXW–3370–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C1200–1205	21–83406D64	5.6 pF, ±.25 pF, 500V
	21–80067A62	82 uF, ±5%, 200V
impedance network		
Z852	01–80739T33	coax assembly includes:
	30–83361G01	coax
	76–83466K01	ferrite bead, 2 used
mechanical parts		
	76–83466K01	ferrite bead, 2 used
	02–80006A01	nut spanner
	03–00132127	tapping screw 6–20X3/4
	03–10911A11	machine screw M3 x .5 x 8, 8 used
	03–10911A12	machine screw M3 x 0.5 x 10, 3 used
	03–10943M10	tapping screw TT3 x 0.5 x 8, 7 used
	03–10943M15	tapping screw TT3.5 x 0.6 x 8, 6 used
	04–00114522	lock washer
	04–82470N01	mounting washer, 3 used
	04–84180C01	shoulder washer, 3 used
	14–83901M01	lower bus insulator
	15–80105B02	housing
	15–80124B01	harmonic filter cover
	26–80169B01	PA cover
	29–84093M01	solder lug, 6 used
	32–83896M01	RF gasket
	39–80203C02	finger contact
	42–10128A18	retaining ring
	42–10217A02	tie strap, 4 used
	42–80013A01	coax clip
	42–80167B01	bus top clip
	42–83982M01	cable clip
	42–84510M04	PA strap, 2 used
	76–84069B04	ferrite bead, 11 used

9/1/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN4217A Feedthru Plate — MXW–6889–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	01–80064L04	feedthru plate assembly includes:
C1180–1187	21–82812H03	.001 uF, +100, –0%, 500V
	04–83755H01	solder washer (8 used)
	64–80122B01	feedthru palte

9/1/89

TRN8854A Final Amplifier — MXW–3377–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C850–857	21–11078B15	12 pF, ±5%, 100V
C859–861	21–11078B32	39 pF, ±5%, 100V
C863,864	21–13740A31	12 pF, ±10%, 50V
C865	21–13740A43	39 pF, ±10%, 50V
diode (see note)		
CR850	48–84616A11	hot carrier
coil, RF		
L850–852	24–80089G01	ferrite, 3 turns
transistor (see note)		
Q850,851	48–84411L43	NPN
thermistor		
RT850	06–82696B01	thermistor
resistor, fixed, ohm, +5%, 1/4 watt (unless otherwise stated)		
R850	06–11009C01	10
non–referenced items		
	42–80163B03	connecting strap
	42–84417K01	substrate holder

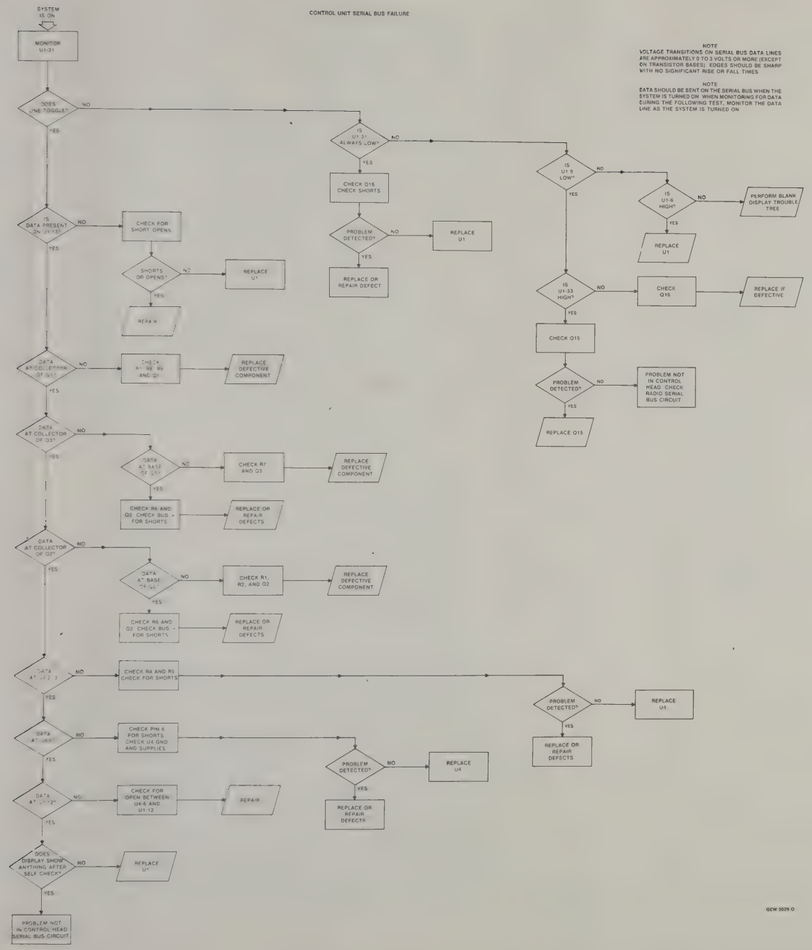
6/30/89

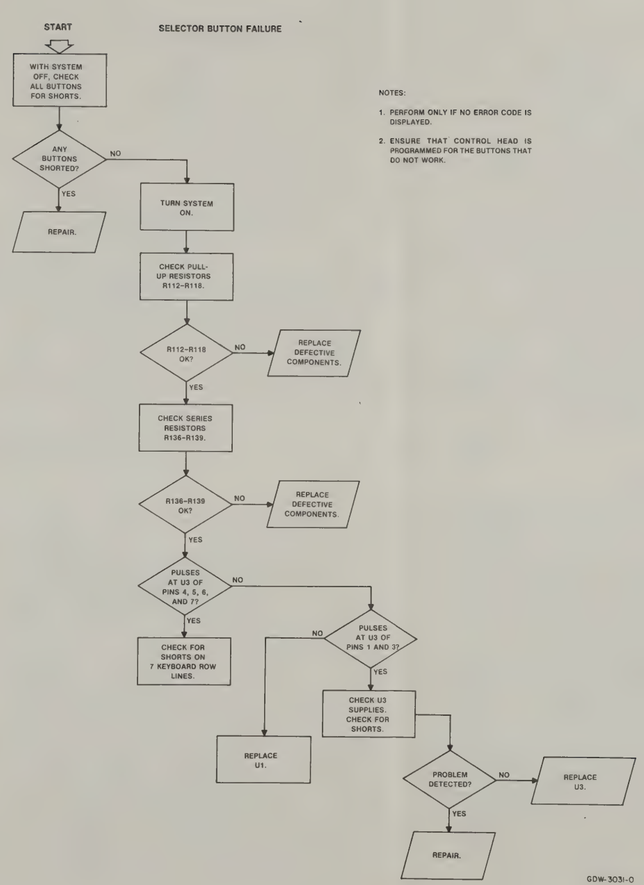
note: Field repair of this kit is not recommended. It should be replaced in its entirety. Parts listed are for reference only.

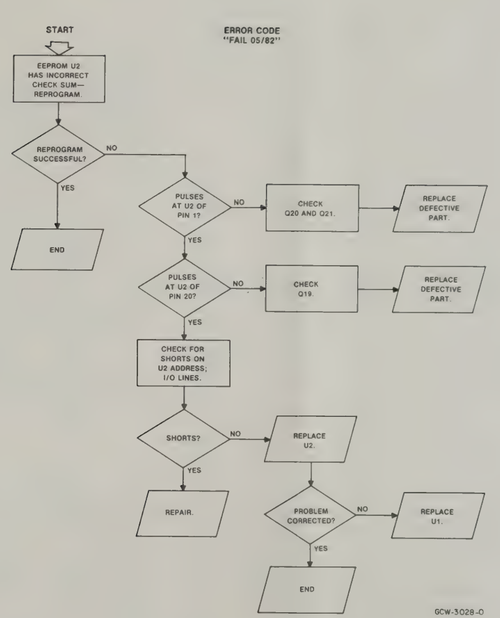
TRN8850A Harmonic Filter Module — MXW–3378–A

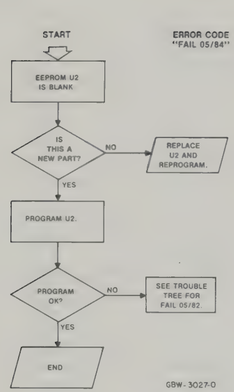
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1350	06–11009C97	100k, ±5%, 1/4W
M1	07–80123B01	harmonic filter frame

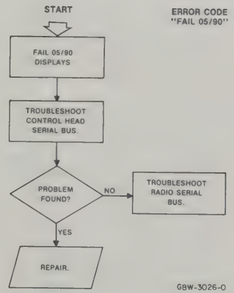
5/10/88



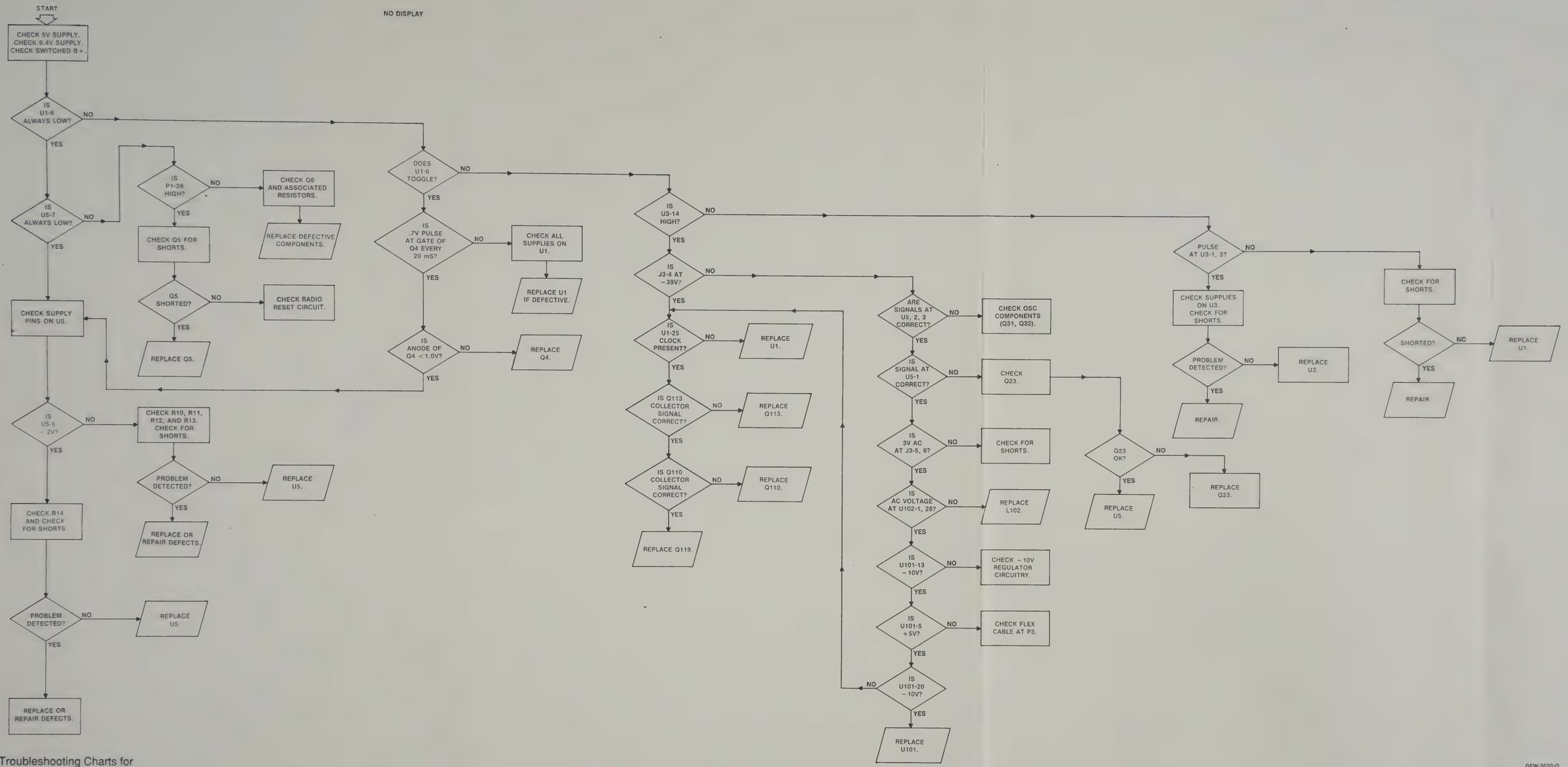








Troubleshooting Charts for
Systems 9000 Control Unit
PW–6220–O
(Sheet 1 of 2)
1/25/89



Troubleshooting Charts for
Systems 9000 Control Unit
PW–6220–O
(Sheet 2 of 2)
1/25/89

GEW-3030-O

MOTOROLA
Mobile Products Division

Common Circuits Board for *SYNTOR X 9000* and *SYNTOR X 9000E*

Section Contents

technical publication services
5555 North Beach Street, Fort Worth, Texas 76137
T10005–B
7/31/89

Common Circuits Board

1. Description

Common board circuitry performs two functions: voltage regulation and RF amplifier power control. The circuit description, theory of operation, and troubleshooting chart for the RF power control are in the transmitter section of your manual. This section covers the voltage regulators.

2. Regulator Theory of Operation

The voltage regulators consist of the 1000 series part designators. The regulator voltages are: switched 9.6 volts, switched 5 volts, and unswitched 5 volts. The power switch at the control unit controls the switched supplies (9.6 and 5 volts). The unswitched 5 volt supply remains powered up as long as the A+ lead to the radio is live, and the B– lead provides a ground return path.

2.1 9.6 VOLT REGULATOR

The 9.6 volt regulator obtains its reference from the zener diode on HY1000. The reference voltage input of U1000B at pin 5 is approximately 7.0 volts DC. The output of U1000B at pin 4 is the 9.6 volt reference. U1000C, Q1001, and the output transistor Q1000 amplifies this reference voltage. If a short circuit occurs on the 9.6 volt supply line, the diode CR1001 forward biases, removes base drive to Q1001, and shuts down the regulator to prevent further damage.

2.2 UNSWITCHED 5 VOLT REGULATOR

The TO220 packaged device U1001 contains the unswitched 5.0 volt regulator. The device generates its own reference, and is internally current limited and thermally protected. The switched 5 volt supply uses this unswitched voltage as reference, so the two regulated voltages closely track each other.

2.3 SWITCHED 5 VOLT SUPPLY

The switched 5 volt supply obtains its reference voltage from the unswitched 5 volt supply. The switched 5 volt supply is protected against excessive output current drain. Excessive current drain is sensed by the output resistors R1021 and R1022. If the drop across these resistors is .6 volts or more, the transistor Q1005 begins to conduct. This begins starving base drive to the output Darlington transistor Q1006.

2.4 SHUTBACK CIRCUIT

Both the switched supplies (5 and 9.6 volt) switch on and off by the shutback circuit. The shutback circuit senses the SW B+ line voltage, and turns the regulators off if line voltage is irregular. The shutback circuit senses over and under voltage conditions on the SW B+ line. The 9.6 volt regulator shuts back through Q1002. The base of Q1002 normally pulls low through R1006 and allows a path for Q1001 emitter current. When shut back, the base of Q1002 is pulled high by Q1004 and turns the 9.6 volt regulator off. The switched 5.0 volt regulator is shut back in a similar manner. The 5.0 volt supply is shut back through the diode CR1003. The diode is normally reverse biased and has no effect on the circuit. When shut back, the diode conducts and forces the op–amp output (U1000D) low. This causes the regulator to shut off completely. The shutback circuit senses the low–line shutback condition through the op–amp U1000A. The op–amp compares the unswitched 5.0 voltage on its positive input with the resistively divided SW B+ input on its negative input.

The circuit shuts back the regulators when SW B+ falls to approximately 8.5 volts, and turns on when SW B+ is over 9.4 volts. The high line shutback is sensed by 18–volt zener diode VR1000. This diode is presented with the SW B+ line voltage by Q1003. VR1000 has no effect to the circuit until SW B+ reaches about 20.5 volts. The 18–volt zener then conducts and clamps the base voltage of Q1004 to 19 volts. As SW B+ rises, the transistor Q1004 conducts and shuts back the switched regulators at high SW B+ voltages.

3. Regulator Troubleshooting

The following situations are explained to help troubleshoot the regulators in the *SYNTOR X 9000* radio.

- Failure of the switched 5.0 and 9.6 volt regulators
- Failure of the unswitched 5.0 volt regulator ONLY
- Failure of the 9.6 volt regulator ONLY
- Failure of the switched 5.0 volt regulator ONLY

3.1 BOTH 5 AND 9.6 VOLT REGULATOR FAILURE

(1) Inspect P300 and J1 and verify that they are properly installed.

(2) Measure SW B+ on the common circuits board. This voltage range is 10.7 to 16.2 volts. If SW B+ is outside of this range, the regulator shutback circuitry disables the regulators.

(3) Measure the voltage at the collector of Q1004. It should be .6 volts or less. If the collector is above .6 volts, repair the shutback circuit.

3.2 UNSWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input to U1001 pin 1. This range is 10.7 to 16.2 volts. If not, repair the open path A+ or B– to the common circuits board.

(2) Measure the resistance from U1001 pin 2 to J1–B on the personality board. This should be below .1 ohms. If not, locate the resistive path or connector and repair.

(3) Measure the output of U1001 pin 3. If not between 4.75 to 5.25 volts, unsolder pin 3 to determine if the supply is shorted. If the unconnected output is not five volts, replace U1001.

3.3 9.6 VOLT REGULATOR FAILURE

(1) Measure the voltage at the emitter of Q1000. It should be between 10.7 to 16.2 volts. If not, find the open path supplying the collector.

(2) Check the op–amp output at U1000B pin 4. It should be 6.65 to 7.35 volts. Next, check U1000B pins 5 and 6. Reading should be 6.2 volts. If not, repair the reference circuit.

(3) Measure the base voltage on Q1001. This point is normally at 3.1 volts. If this point is below 2 volts or above 6 volts, repair the driving op–amp circuit involving U1000A.

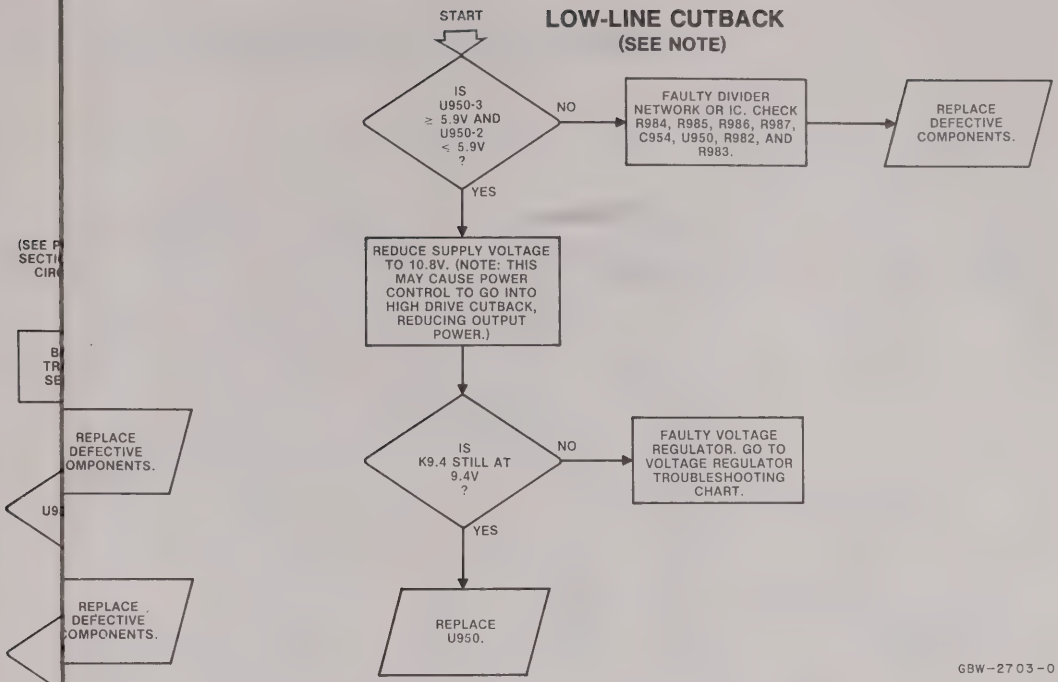
(4) Measure the voltage on the base of Q1000 (output pass transistor). The base voltage should be .5 to .8 volts below the SW B+ voltage on the emitter of Q1000. If this voltage is out of range, repair the output driver involving Q1000 and Q1001.

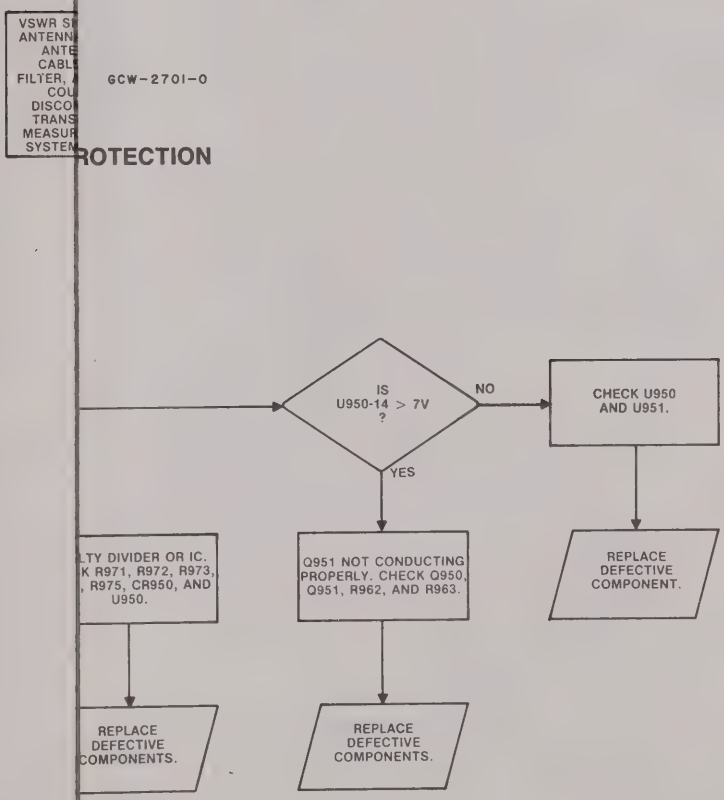
3.4 SWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input reference voltage at U1000D pin 13, This should be 4.75 to 5.25 volts. If not, recheck the unswitched 5.0 volt regulator output. If the unswitched 5.0 supply is present, unsolder U1000 pin 13 to check if U1000 is faulty.

(2) Check the collector voltage of Q1005. Acceptable range is 10.7 to 16.2 volts. If not, find the open path to the common circuits board.

(3) Measure the driving op–amp U1000 pin 12 to determine if sufficient base drive is present for Q1006. U1000 pin 12 should be 6.4 to 7 volts. If this voltage is more than 7 volts, check the voltage drop across R1016. The drop is approximately .2 volts. If there is little or no drop across R1016, replace Q1006. If the voltage drop is excessive, remove Q1005 to disable the current shutback circuit, and recheck. Should the drop still be excessive, measure the drop across R1021. If R1021 drop is more than .7 volts, locate the fault on the switched 5.0–volt line. This fault is probably on another circuit board in the radio. If the R1021 voltage drop is less than .7 volts, replace Q1006. If the voltage on U1000 pin 12 is below 6.4 and pin 14 is less than pin 13 of U1000, replace U1000. If U1000 pin 14 is more than pin 13, check for an open R1017 or shorted CR1003.


START
LOW-LINE CUTBACK
(SEE NOTE)
IS U950-3 ≥ 5.9V AND U950-2 ≤ 5.9V ?
NO
FAULTY DIVIDER NETWORK OR IC. CHECK R984, R985, R986, R987, C954, U950, R982, AND R983.
REPLACE DEFECTIVE COMPONENTS.
YES
REDUCE SUPPLY VOLTAGE TO 10.8V. (NOTE: THIS MAY CAUSE POWER CONTROL TO GO INTO HIGH DRIVE CUTBACK, REDUCING OUTPUT POWER.)
IS K9.4 STILL AT 9.4V ?
NO
FAULTY VOLTAGE REGULATOR. GO TO VOLTAGE REGULATOR TROUBLESHOOTING CHART.
YES
REPLACE U950.
GBW-2703-0


IS U950-14 > 7V ?
NO
CHECK U950 AND U951.
YES
Q951 NOT CONDUCTING PROPERLY. CHECK Q950, Q951, R962, AND R963.
REPLACE DEFECTIVE COMPONENT.
REPLACE DEFECTIVE COMPONENTS.
GCW-2702-0

3.1 BOTH 5 AND 9.6 VOLT REGULATOR FAILURE

(1) Inspect P300 and J1 and verify that they are properly installed.

(2) Measure SW B+ on the common circuits board. This voltage range is 10.7 to 16.2 volts. If SW B+ is outside of this range, the regulator shutback circuitry disables the regulators.

(3) Measure the voltage at the collector of Q1004. It should be .6 volts or less. If the collector is above .6 volts, repair the shutback circuit.

3.2 UNSWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input to U1001 pin 1. This range is 10.7 to 16.2 volts. If not, repair the open path A+ or B– to the common circuits board.

(2) Measure the resistance from U1001 pin 2 to J1–B on the personality board. This should be below .1 ohms. If not, locate the resistive path or connector and repair.

(3) Measure the output of U1001 pin 3. If not between 4.75 to 5.25 volts, unsolder pin 3 to determine if the supply is shorted. If the unconnected output is not five volts, replace U1001.

3.3 9.6 VOLT REGULATOR FAILURE

(1) Measure the voltage at the emitter of Q1000. It should be between 10.7 to 16.2 volts. If not, find the open path supplying the collector.

(2) Check the op–amp output at U1000B pin 4. It should be 6.65 to 7.35 volts. Next, check U1000B pins 5 and 6. Reading should be 6.2 volts. If not, repair the reference circuit.

(3) Measure the base voltage on Q1001. This point is normally at 3.1 volts. If this point is below 2 volts or above 6 volts, repair the driving op–amp circuit involving U1000A.

(4) Measure the voltage on the base of Q1000 (output pass transistor). The base voltage should be .5 to .8 volts below the SW B+ voltage on the emitter of Q1000. If this voltage is out of range, repair the output driver involving Q1000 and Q1001.

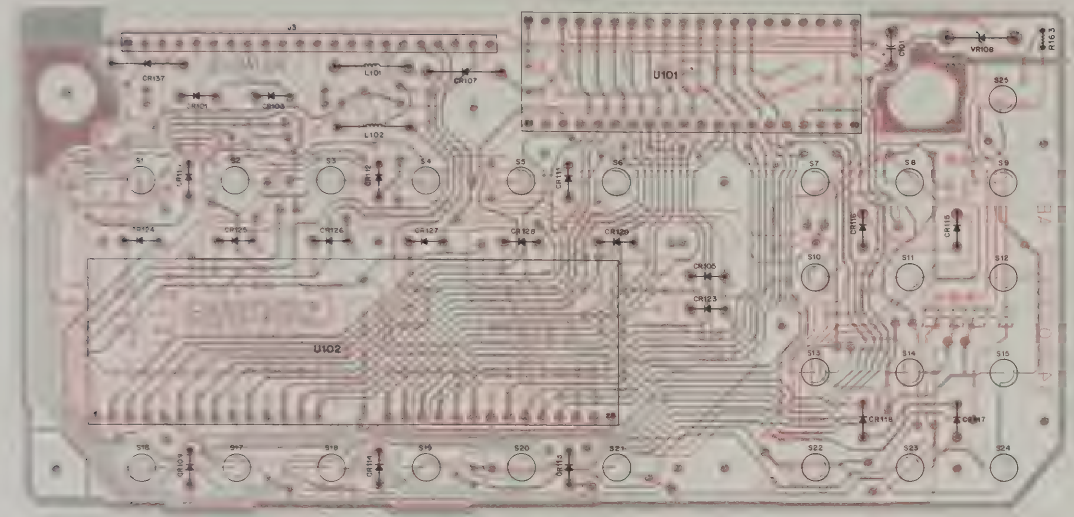
3.4 SWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input reference voltage at U1000D pin 13, This should be 4.75 to 5.25 volts. If not, recheck the unswitched 5.0 volt regulator output. If the unswitched 5.0 supply is present, unsolder U1000 pin 13 to check if U1000 is faulty.

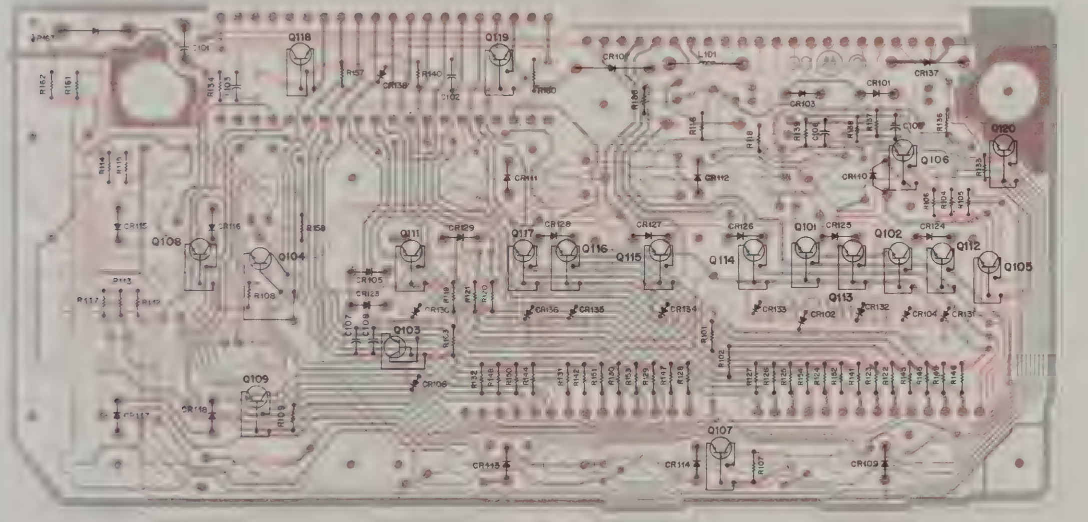
(2) Check the collector voltage of Q1005. Acceptable range is 10.7 to 16.2 volts. If not, find the open path to the common circuits board.

(3) Measure the driving op–amp U1000 pin 12 to determine if sufficient base drive is present for Q1006. U1000 pin 12 should be 6.4 to 7 volts. If this voltage is more than 7 volts, check the voltage drop across R1016. The drop is approximately .2 volts. If there is little or no drop across R1016, replace Q1006. If the voltage drop is excessive, remove Q1005 to disable the current shutback circuit, and recheck. Should the drop still be excessive, measure the drop across R1021. If R1021 drop is more than .7 volts, locate the fault on the switched 5.0–volt line. This fault is probably on another circuit board in the radio. If the R1021 voltage drop is less than .7 volts, replace Q1006. If the voltage on U1000 pin 12 is below 6.4 and pin 14 is less than pin 13 of U1000, replace U1000. If U1000 pin 14 is more than pin 13, check for an open R1017 or shorted CR1003.

DISPLAY BOARD



COMPONENT SIDE VIEW



SOLDER SIDE VIEW

parts list

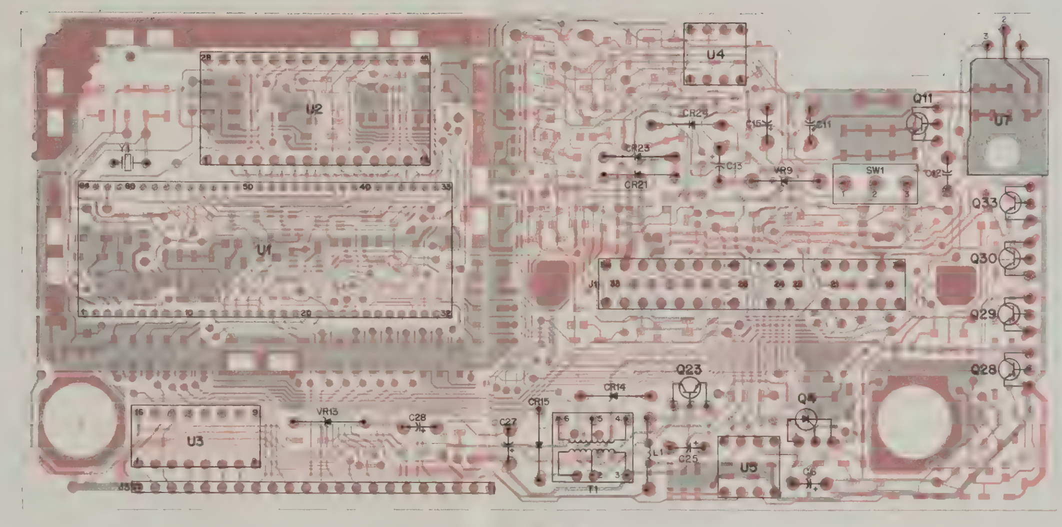
HLN5104D *Systems 9000* Display Board — MXW–4382–D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101	23–11048C11	10, ±20%, 44V, electrolytic
C102	21–13741N21	.001
C103–108	21–11032B13	.1, +80, –20%
diode (see note)		
CR101	48–80026P03	red LED
CR102	48–80236E08	silicon
CR103	48–80026P04	yellow LED
CR104	48–80236E08	silicon
CR105	48–80026P03	red LED
CR106	48–80236E08	silicon
CR107	48–83654H01	silicon
CR109–118	48–80246K04	green LED
CR123	48–80026P04	yellow LED
CR124–129	48–80026P03	red LED
CR130–136	48–80236E08	silicon
CR137	48–84616A11	silicon
CR138	48–80236E08	silicon
coil, RF		
L101	24–11047A44	390 uH
L102	24–80138G07	15.0 uH, ±5%
transistor (see note)		
Q101–103	48–80141L02	NPN
Q104	48–80141L04	NPN
Q105–120	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R101–103	06–11077A50	100
R104	06–11077A90	4.7k
R105–107	06–11077A64	390
R108	06–11077A84	2.7k
R109	06–11077A36	27
R112–118	06–11077B23	100k
R119	06–11077A50	100
R120,121	06–11077A57	200
R122–132	06–11077B23	100k
R133,134	06–11077A98	10k
R135	06–11077A50	100
R136–139	06–11077A90	4.7k
R140–154	06–11077B23	100k
R157	06–11077B11	33k
R158	06–11077A70	680
R159	06–11077A01	0
R160	06–11077B11	33K
R161	06–11077A94	6.8k
R162	06–11077A92	5.6k
R163	06–83600K09	100k green thermistor
R164	06–11077A98	10k
R200,201	06–11077A74	1k
integrated circuit (see note)		
U101	51–80236C04	display driver
U102	72–80242J01	vacuum–florescent display
varactor		
VR108	48–82256C67	10V zener 1W

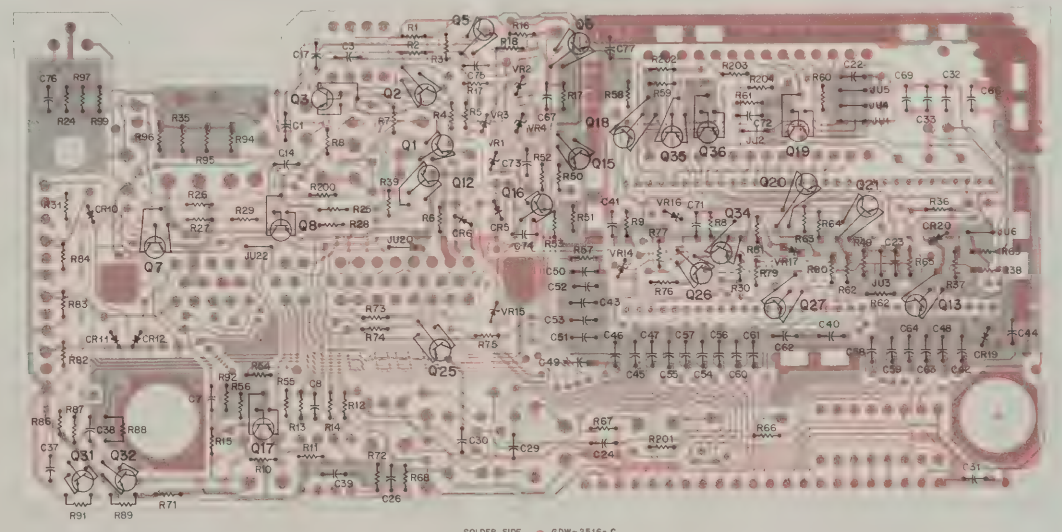
6/30/89

note: For best performance order diodes, transistors, and integrated circuit devices by Motorola part number.

CONTROLLER BOARD



COMPONENT SIDE VIEW



SOLDER SIDE VIEW

parts list

HLN5104D *Systems 9000* Controller Board — MXW–4381–D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21–11032B13	.1, +80, –20%
C3	21–13740B60	300 pF
C6	23–11048C05	1, ±20%, 63V, electrolytic
C7	21–11032B01	.001, +80, –20%
C8	21–13740B57	220 pF
C11	23–11048C10	10, ±20%, 63V, electrolytic
C12,13	23–11048C05	1 ±20%, 63V, electrolytic
C14	21–13740B39	39 pF
C15	23–11048C06	2.2 ±20%, electrolytic
C17	21–11032B13	.1, +80, –20%
C22,23	21–11032B13	.1, +80, –20%
C24	21–11032B15	.22, +80, –20%
C25	23–11054H08	10, ±10%, 25V, tantalum
C26	21–11032B13	.1, +80, –20%
C27,28	23–11048C10	10, ±20%, 63V, electrolytic
C29,30	21–11032B01	.001, +80, –20%
C31	21–11032B13	.1, +80, –20%
C32	21–13740B34	24 pF
C33	21–13740B31	18 pF
C37,38	21–13740B[illegible]	820 pF
C39–66	21–13740B60	300 pF
C67	21–13741N45	.01, ±10%
C69	21–13740B[illegible]	5.6 pF, ±.5 pF, 50V
C71	21–13741N45	.01, ±10%
C72	21–13740B39	39 pF
C73–76	21–13740B57	220 pF
C77	21–13740B60	300 pF
C78–80	21–13741N45	.01, ±10%
C81	21–13740B60	300 pF
diode (see note)		
CR5,6	48–80236E08	silicon
CR10–12	48–80236E08	silicon
CR14,15	48–83654H01	silicon
CR19,20	48–80236E08	silicon
CR21	48–82466H[illegible]	rectifier
CR23,24	48–84616A11	silicon
jumper		
JU2	06–11077A01	0 ohm
JU5–7	06–11077A01	0 ohm
JU23	06–11077A01	0 ohm
connector receptacle		
J1	28–80228J01	50 contact mini D connector
coil, RF		
L1	24–80138G04	5.6 uH, ±5%
transistor (see note)		
Q1	48–80141L01	PNP
Q2	48–80141L03	PNP
Q3	48–80141L04	NPN
Q4	48–80182D22	SCR
Q5	48–80141L03	PNP
Q6	48–80141L04	NPN
Q7	48–80141L03	PNP
Q8	48–80141L04	NPN
Q11	48–801[illegible]	NPN
Q12	48–80141L04	NPN
Q13	48–80141L01	PNP
Q15	48–80141L03	PNP
Q16	48–80141L04	NPN
Q17,18	48–80141L03	PNP
Q19	48–80141L02	NPN
Q20	48–80141L03	PNP
Q21	48–80141L02	NPN
Q23	48–00869732	PNP
Q25–27	48–80141L03	PNP
Q28–30	48–80182D28	NPN
Q31	48–80141L02	NPN
Q32	48–80141L02	NPN
Q33	48–80182D08	NPN
Q34	48–80141L04	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R1	06–11077A82	2.2k
R2	06–11077A98	10k
R3	06–11077A90	4.7k
R4,5	06–11077A50	100
R6	06–11077A90	4.7k
R7	06–11077A98	10k
R8	06–11077A82	2.2k
R9	06–11077B05	18k
R10,11	06–11077B31	220k
R12	06–11077A90	4.7k
R13	06–11077B23	100k
R14	06–11077B11	33k
R15	06–11077A98	10k
R16	06–11077A90	4.7k
R17	06–11077B15	47k
R18	06–11077B11	33k
R19	06–11077A98	10k
R24	06–11077A36	27
R25	06–11077A74	1k
R26	06–11077B07	22k
R27	06–11077A98	10k
R28	06–11077B15	47k
R29	06–11077A90	4.7k
R30,31	06–11077B11	33k
R35	06–11077A70	680
R36–38	06–11077A82	2.2k
R39	06–11077A98	10k

MXW–4381–D (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R49	06–11077B15	47k
R50	06–11077A90	4.7k
R51	06–11077A86	3.3k
R52	06–11077A90	4.7k
R53	06–11077A74	1k
R54	06–11077B07	22k
R55	06–11077A98	10k
R56	06–11077A90	4.7k
R57,58	06–11077A98	10k
R59	06–11077B15	47k
R60	06–11077A90	4.7k
R61,62	06–11077B15	47k
R63	[illegible]	[illegible]
R64	[illegible]	[illegible]
R65	06–11077B15	47k
R66	06–11077A94	6.8k
R67	06–11077B06	20k
R68	06–11077A74	1k
R69,70	06–11077B15	47k
R71	06–11077A82	2.2k
R72	06–11077A74	1k
R73	[illegible]	[illegible]
R74	[illegible]	[illegible]
R75	06–11077B15	47k
R76	06–11077B07	22k
R77	06–11077A98	10k
R78	06–11077B15	47k
R79	[illegible]	[illegible]
R80	06–11077A98	10k
R81	06–11077B15	47k
R82–84	06–11077B11	33k
R86	06–11077A98	10k
R87	06–11077A84	2.7k
R88	06–11077A98	10k
R89	06–11077A84	2.7k
R91,92	06–11077A74	1k
R94–96	06–11077A70	680
R97	06–11077A36	27
R99	06–11077A36	27
switch		
S1	40–80033K01	toggle
transformer		
T1	25–80277J03	voltage conversion
integrated circuit (see note)		
U1	———	control unit software (see model chart)
U2	———	EEPROM software (see model chart)
U3	51–83627M42	bipolar
U4	51–80067C05	opamp
U5	51–80046K01	compartor
U7	51–80068C02	voltage regulator
varactor (see note)		
VR1–4	48–80140L11	7.5V zener
VR9	48–82256C67	10V zener, 1W
VR13	[illegible]	[illegible] zener
VR15–17	48–80140L11	7.5V zener
crystal (see note)		
Y1	48–80113K03	4.9152 MHz
non–referenced items		
	01–80740T41	component side shield assembly
	26–80003K01	component side shield
	55–84300B02	handle
	05–80200K01	nylon rivet
	09–80002K01	IC socket
	09–80269B03	dual IC socket
	14–80076L01	insulator shield
	14–80269K01	insulator
	26–80220K01	solder side shield
	29–10134A68	connector lug, 6 used
	32–80179J01	D connector gasket
	32–80181J01	face connector gasket
	43–80011L01	8 position LED spacer
	43–80012L01	2 position LED spacer
	54–80111F01	PROM label
	75–05295B01	crystal base pad
	75–80098J01	keypad
	75–80184J01	VF shock pad
	75–80268K01	IC shock pad
	29–10134A70	connector lug, 6 used

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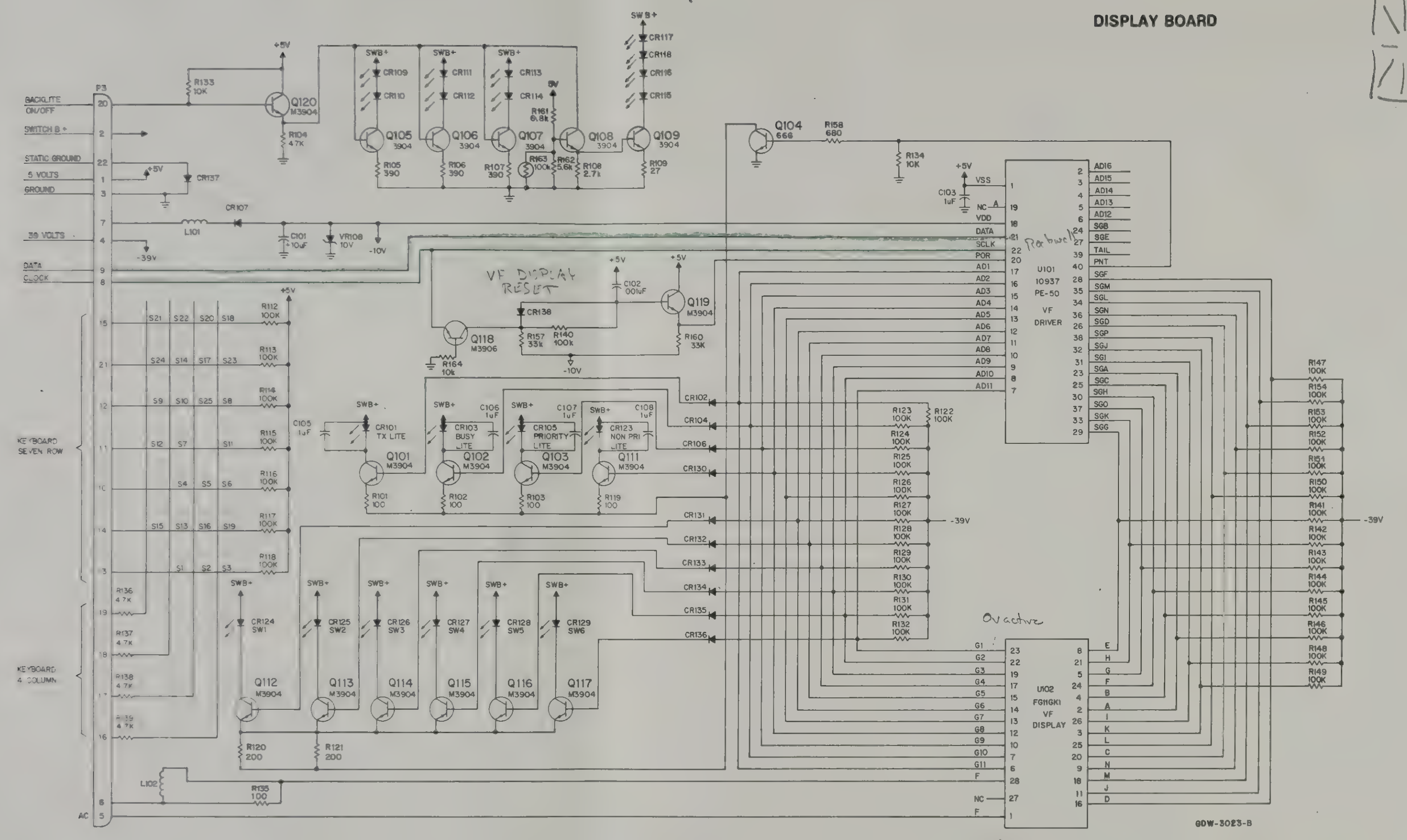
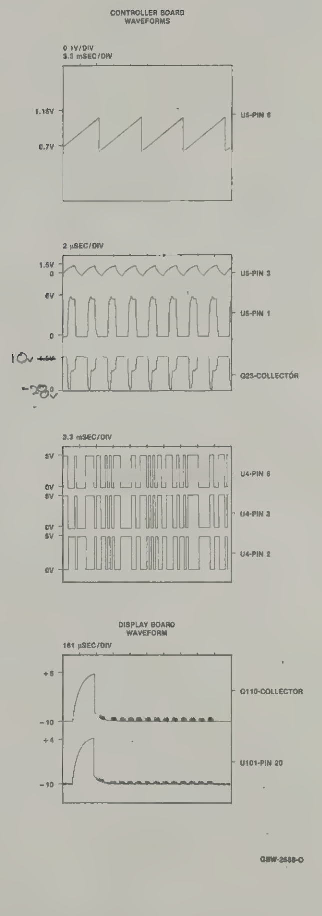
note: For best performance order diodes, transistors, and integrated circuit devices by Motorola part number.

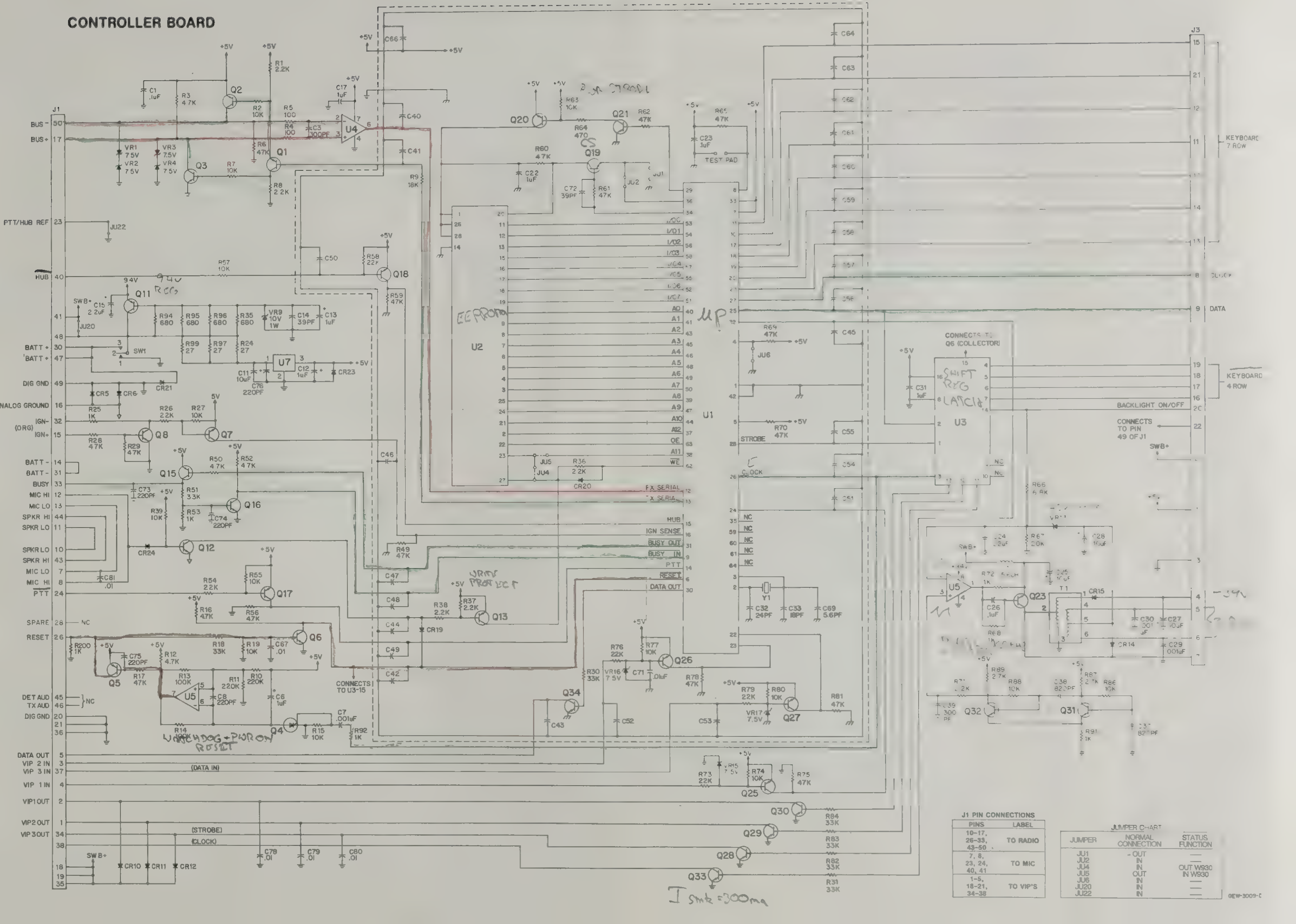
Schematics, Circuit Board Diagrams, and Parts Lists for the Control Unit
PW–4385–E
(Sheet 1 of 2)
9/28/89

DISPLAY BOARD





CONTROLLER BOARD



J1 PIN CONNECTIONS

PINS	LABEL
10–17, 26–33, 43–50	TO RADIO
7, 8, 23, 24, 40, 41	TO MIC
1–5, 18–21, 34–38	TO VIP'S

JUMPER CHART

JUMPER	NORMAL CONNECTION	STATUS FUNCTION
JU1	- OUT	—
JU2	IN	—
JU4	IN	OUT W930
JU5	OUT	IN W930
JU6	IN	—
JU20	IN	—
JU22	IN	—

GEW-3009-C

Schematics, Circuit Board Diagrams, and Parts Lists for the Control Unit
PW-4385-E
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MOTOROLA
Mobile Products Division

Control Unit, Cable Kits, and Accessories

Section Contents

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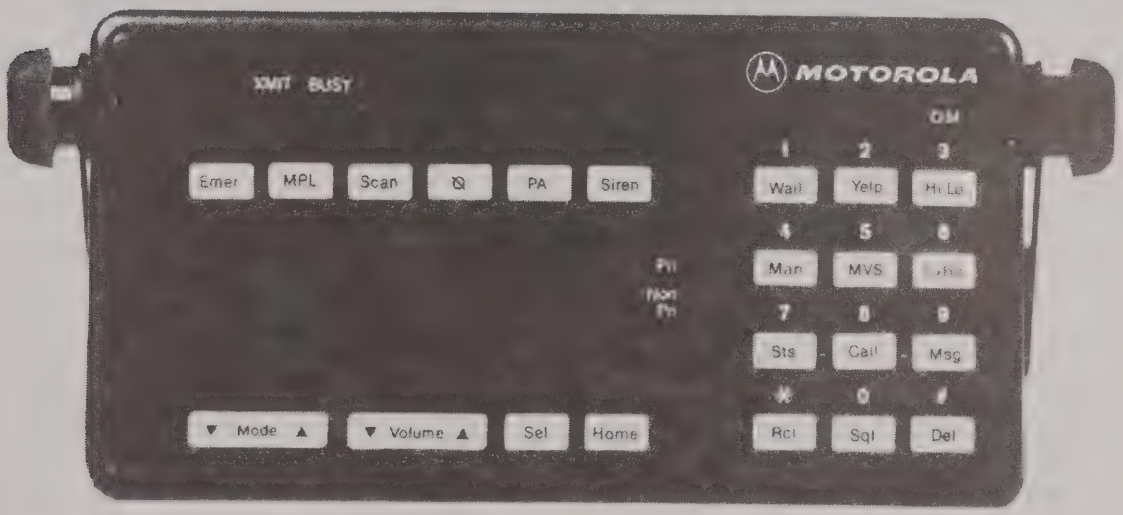
Control Unit, Cable Kits and Accessories



GPW–2538–A

Figure 1. Typical Systems 9000 *Control Unit*

1. Description

1.1 GENERAL

Note

A variety of Motorola's *SYNTOR X 9000* radio systems use the *Systems 9000* Control Unit. The differences between control units is in the programming software and button legends.

The *Systems 9000* control unit is a microcomputer based unit that processes all the button inputs and displays used by the radio and the options. It also interfaces with the vehicle via the vehicle interface ports (VIP).

1.2 CONTROLS AND INDICATORS

1.2.1 Power Switch

The power switch is a slide switch on the right–hand bottom surface of the control unit. It turns the radio and its accessories on and off.

1.2.2 Display

The eleven–character vacuum fluorescent display's primary function is to display mode numbers, mode names, volume level, and the status of options. It also functions as an on–off indicator for the entire system, and plays an integral role in the operator's reconfiguration of options.

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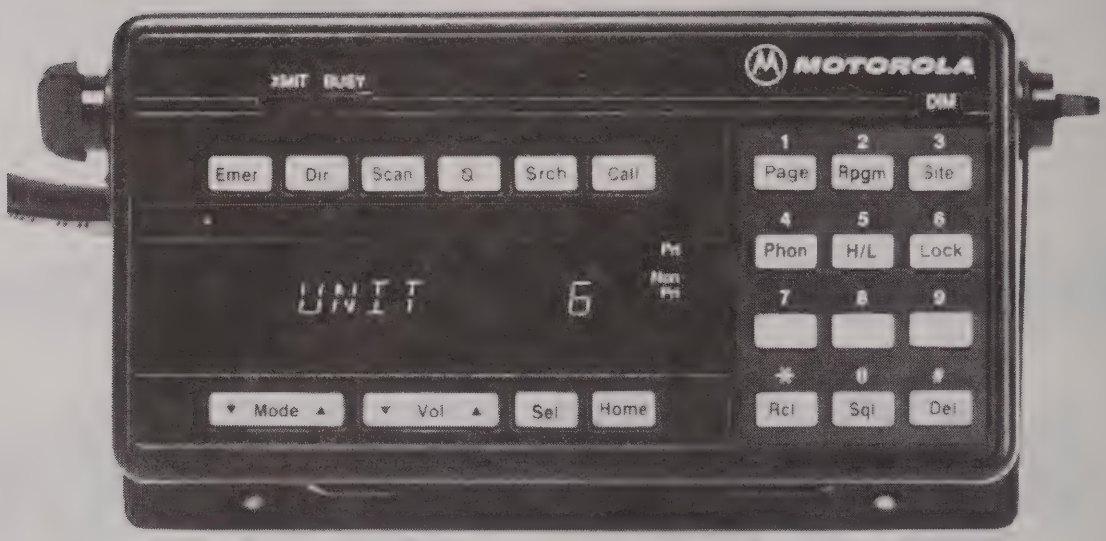


Figure 2. Systems 9000 *Control Unit for* SYNTOR X 9000E *Radios* GPW–4141–A

1.2.3 Option Buttons

Located above the display window is a row of six buttons for turning options on and off. Below each is a small indicator light to show the status of the option.

1.2.4 XMIT and BUSY Indicators

Above the six option buttons are XMIT and BUSY indicators. The XMIT indicator lights when the radio is transmitting. The BUSY indicator lights when the selected channel is busy.

1.2.5 Scan Indicators

In the right–hand side of the display window are the NON–PRI and PRI indicator lights. When scan operation detects activity on a non–priority (NON–PRI) channel, the NON–PRI light comes on. Activity on a second priority channel causes PRI to light. First priority channel activity causes PRI to flash.

1.2.6 Mode Rocker Switch

Below the display window is the Mode rocker. Pressing the right side of this rocker switch increases the mode number. Press the left side to decrease the mode number. If you press and hold the switch, it scrolls the mode numbers up or down. The mode names appear in the display window.

1.2.7 Volume Rocker Switch

Below the display window, beside the Mode switch is the Volume rocker. Press and release to check volume setting. Your display shows "VOLUME _ _" and a number value (0–15). Press and hold the right side of the rocker to increase the volume setting. Press and hold the left side to decrease volume. The number value scrolls up or down to your desired level.

The volume rocker also controls the volume level of the public address (PA) and external radio speaker (ExRd) options when they are enabled. The display window shows "PA VOL_ _" when public address is on and the volume rocker is pressed.

1.2.8 Home and Sel Buttons

Press the Home button to go to the radio's pre–programmed "Home" mode. You may use Home instead of Mode to change modes. Hold Home until a beep sounds to enter the configuration state. The display shows an entry prompt. Use the keypad to enter your new mode choice and press Home again. Your mode is now changed without scrolling.

Use the Sel button when configuring an option. See the descriptions of the options for more specific information.

1.2.9 DIM Button

Above the keypad, on the right side of the control unit, is the control for the brightness of the display and button backlighting. When you turn on the system, the display comes on at the highest level. Press DIM once to reduce the brightness of the display to medium level, and twice for low brightness level. Press DIM a third time to turn the display and button backlighting off. This is called the "surveillance" mode.

1.2.10 Keypad

The keypad is for changing the status of options and entering numbers to the display. See the Operator's Manual for a complete description of button operation.

2. Theory of Operation

2.1 GENERAL

The *Systems 9000* control unit has solid state microprocessor circuitry that operates the standard and optional features built into the system. The control unit design allows installation in even the smallest of down–sized vehicles. Systems that have many options simply require more control unit buttons, not larger control units.

The control unit may be field programmed to alter the information stored in certain areas of its electronic memory. Some options are also added by field programming.

2.1.1 Display

The control unit has an eleven–character alphanumeric vacuum fluorescent display for indicating the following:

- Mode Names
- Squelch Level
- Volume Level
- Status Codes
- Message Codes
- Telephone Numbers
- Identification Numbers
- Alarm Displays
- Option Status

2.1.2 Controls and Indicators

A twelve button keypad contains traditional alphanumeric keys. These keys double as function keys for *SYNTOR X 9000* options. All buttons are backlit to allow operation in low–light. Six ON/OFF option buttons and indicator lights above the display window tell whether these options are on or off.

Other indicators include BUSY, TRANSMIT, PRIORITY, and NON–PRIORITY. BUSY lights when activity is detected on the channel. The XMIT (transmit) indicator lights when you are transmitting.

When activity occurs during a Scan sequence, the NON–PRI (non–priority) or PRI (priority) light is on. If the detected activity be on a NON–PRI mode, the NON–PRI light is on. If the activity is on PRI mode the PRI indicator lights for second priority modes, and flashes for first priority modes.

2.2 CONTROL BOARD

The control board's microprocessor (MPU) communicates on the serial bus, receives and interprets keypad data, and controls the volume. The MPU sends ASCII data to a decoder to control the display, and sends data to turn the LEDs on or off. The control board has a watchdog timer that senses the need for a system reset. The vehicle interface ports are also controlled on this board.

2.2.1 Microprocessor (MPU)

The MPU operates in mode 2 (expanded bus with internal ROM active). Table 1 gives jumper placements for different modes. The clock frequency is 4.9152 MHz that results in an internal operating frequency of 1288 kHz. The limited number of I/O ports is augmented by using a serial–to–parallel shift register (U3) to scan the keyboard, and to switch the VIP drivers (Q28, Q29, Q30, and Q33).

Table 1. Mode Jumper Placement

Microprocessor Mode	JU3	JU6
No. 1–Expanded mode with external ROM only.	IN	OUT
No. 2–Expanded mode with internal ROM active.	OUT	IN
No. 3–Single Chip.	OUT	OUT

2.2.2 Watchdog Timer

The watchdog timer consists of U5 (comparator) and Q4 (SCR). On system power–up, C06 pulls the inverting input of U5 high while R10 and R11 hold the non–inverting input at VCC/2. The output goes low and the microprocessor resets.

As C06 charges through R14, the voltage on the inverting input drops below that of the non–inverting input, the output goes high, and the microprocessor can start operating. R14 is now pulling up on C06, and the inverting–input voltage begins to rise.

During this interval, the processor generates tickle pulses to periodically fire Q4, preventing the inverting–input voltage from rising above the non–inverting input voltage and repeating the reset cycle. If the tickle pulses stop for more than 150 mSec, the reset cycle is repeated.

2.2.3 EEPROM

The EEPROM stores customer data including mode names, button functions, and VIP settings. The customer data can be altered only by enabling the "STORE" function (grounding the MIC HI line); an automatic function of the control unit programmer. Power strobing minimizes EEPROM power consumptions. Jumpers configure the EEPROM for the uses shown in Table 2.

Table 2. EEPROM Jumper Table

JUMPER	USE/PLACEMENT
JU1	Used for future options
JU2	IN for 6301X Microprocessor
JU4	IN for 2K EEPROM; OUT for 8K EEPROM (option W930)
JU5	IN for 8K EEPROM (option W930) OUT for 2K EEPROM

2.2.4 Bus Transceiver

The serial bus transceiver consists of Q1, Q2, Q3, and U4 (CA3140). Q1, Q2, and Q3 transmit data on the bus while U4 acts as a comparator to receive data from the bus.

2.2.5 Vacuum Fluorescent Voltage Converter

Voltage for the vacuum fluorescent display is generated by a fixed frequency, variable–duty cycle driven, flyback voltage converter. Q31 and Q32 form an emitter–coupled astable multivibrator that runs at about 150 kHz. The square wave output from this circuit is integrated by R71 and C39 to form a triangle that is applied to the non–inverting input of half of U5.

During start up, the inverting input is biased at 3.7 volts by R66 and R67. Q23 is on while the non–inverting input voltage is below 3.7 volts. This allows current to flow the T1, building a magnetic field. When the triangle wave exceeds 3.7 volts, Q23 turns off and the magnetic field collapses, inducing negative current in T1.

This current flows through either CR13 or CR14, charging C27 and C28. As the voltage on C28 increases beyond –35 volts, CR13 begins to conduct, pulling U5's inverting input below 3.7 volts. This decreases the cycle time that Q23 is on to the time needed to produce –35 volts on C28. The –41 volt sup ply is not regulated, but it tracks the –35 volt supply.

Similarly, the AC supply for the vacuum fluorescent filament is not regulated, but is controlled to within one volt by and inductor on the display board.

2.2.6 Vehicle Interface Ports (VIP)

The VIP outputs are driven by a serial–to–parallel shift register. Output transistors (Q28, Q29, Q30) can sink 300 mA current. Primarily, these transistors control external relays. The relay is connected between the collector and switched B+.

Each VIP input transistor (Q25, Q26, Q27) is connected to a dedicated input port through transistors used for input protection. These VIP inputs are connected to ground with either normally–open or normally–closed switches.

2.2.7 Power Supplies

Both the +5 and the +9.4 volt supplies are linear regulators. The +9.4 supply is built with a discrete transistor (Q11). The regulation is provided by VR09. The +5 volt supply is a 7805, three–terminal regulator IC.

2.2.8 Ignition Sense Circuits

Q7 senses the vehicle ignition's state, disabling transmit when the ignition is off. For negative–ground systems, the orange lead is typically connected to the fuse box (+12V). For more information, see the cable kit section.

2.2.9 EEPROM Write–Protect Circuit

Q12, Q13, and associated circuitry guard against inadvertently writing into the EEPROM. When MIC HI is grounded, Q21 (normally on) is turned off. A hot–carrier diode (CR24) ensures that Q21 turns off. CR24 is normally off so it does not interfere with the MIC HI line.

CR19 forces the system to be write–protected during reset; this is especially crucial during system power–up.

2.3 DISPLAY BOARD

This board contains the main operator interface points of the system, including the vacuum fluorescent display, the status indicator LEDs, and the user keypad.

2.3.1 Vacuum Fluorescent Display

The vacuum fluorescent (VF) display is an eleven digit, 14–segment display that needs three separate voltages to operate: the cathode needs –35 volts to accelerate electrons to the anode; the grid needs –40 volts to totally shut off current flow; the filament needs 3.8 volts AC at 80 mA. These voltages are obtained from the VF up–converter on the controller board.

2.3.2 Vacuum Fluorescent Display Driver

This IC (U101) receives ASCII data from the controller board, decodes it into 14–segment display data, and then scans the display with the data. Once properly loaded into the driver, the displayed data is refreshed without any further processor action. The display driver is periodically reset by the actions of transistors Q118, Q119, and Q110 that watch the clock line from the processor to the display driver. When the clock line is held low for more than 600 mSec, the display driver resets and new display data follows.

2.3.3 Voltage Supply

The AC voltage present on Q23 of the controller board is used to obtain the –10 volts needed to run the display driver IC. This voltage is fed through L101 to limit the current and then rectified by CR107 and shunt regulated by CR108.

2.3.4 Status LEDs

These LEDs are driven by the display driver as though they were decimal points on the VF display. Level shifting transistors are required for this since the display driver uses 39 volts for control signals.

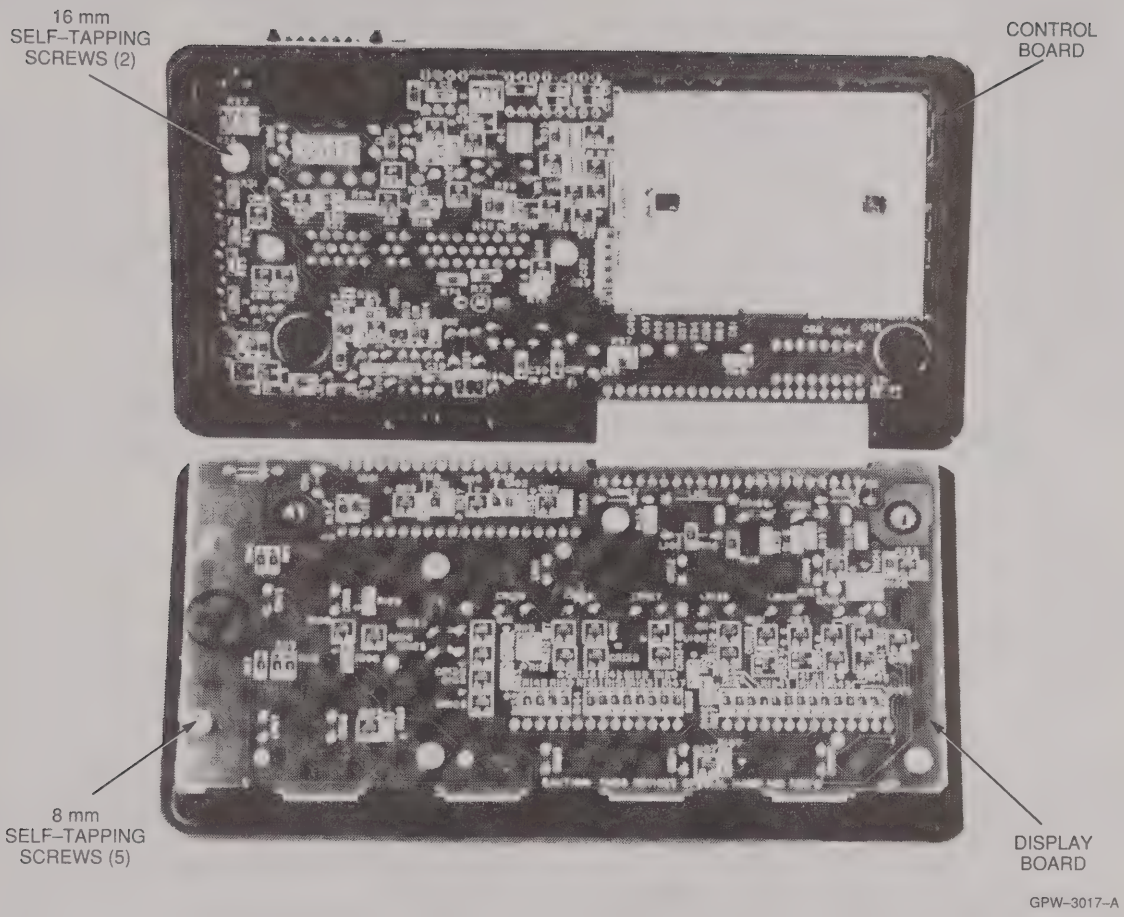


Figure 3. Disassembly of the Control Unit

2.3.5 Backlight LEDs

The same microprocessor signal that turns the VF power supply on and off also operates the backlight LEDs. Q120 supplies base current to the individual LED driver transistors. The driver transistors act as constant current sources to the LEDs. Backlight LEDs CR115, CR116, CR117, and CR118 are connected to thermistor R163 by way of Q108. This circuit allows more current to flow through these LEDs at room temperature and reduces current as the temperature rises.

3. Control Unit Maintenance

3.1 DISASSEMBLY OF CONTROL UNIT
(See Figure 3)

Note

Before disassembling the control unit, note the location of the labeled buttons.

Remove the two 30mm slotted screws that hold the front and back of the control unit together. The two halves separate at the top; at the bottom, they are held together by the flex cable that interconnects the circuit boards. Place the unit so the PC boards are facing up.

Remove the five 8mm screws in the display board and carefully remove the front of the control unit housing. Keep the front housing parts as a complete unit (including the front housing, buttons, and display board light pipe). Always keep the front of the display housing face down when handling.

Remove the two 16mm self–tapping screws on the control board. Remove the back of the control unit housing. Remove the black gasket around the switch and set it aside. Remove the shields from the top and bottom of the control board. All components should be easily accessible.

Note

When working with chips and SOT parts, use extreme caution when heating. Never reuse a chip or SOT part; always replace with correct Motorola parts.

3.2 RE–ASSEMBLY OF THE CONTROL UNIT

Be sure the orange gasket is still around the outside of the control cable "mini D" connector. If it was removed, replace it, ensuring a snug fit to the PC board. Replace the gasket around the power switch. Replace the shields on the top and bottom of the control board. Place the control board in the back housing, being careful to put the toggle switch arm in the proper position in the ON/OFF button actuator.

Screw in the two 16mm self–tapping screws to 6–8 inch lbs. Also, be sure the ON/OFF actuator still slides back and forth easily. Carefully check to see that all buttons are still in place, then place the display board in the front housing. Screw in the five 8mm self–tapping screws to 6–8 inch lbs. Be sure the black gasket is around the outside groove of the front housing. When mating the front and back housings, make sure the flex cable slides behind the control board and is not pinched. Screw in the two 30mm slotted screw to 9–10" lbs.

4. Vehicle Interface Ports

The Vehicle Interface Ports (VIP) allow the control unit to operate outside circuits and to receive inputs from outside the control unit. There are three VIP outputs that are used for relay control. There are also three VIP inputs that accept inputs from switches. See the cable kit section for typical connections of VIP input switches and VIP out put relays.

4.1 VIP OUTPUT CONNECTIONS

The VIP output pins are located on the back of the control unit below the area labeled "VIP." These connections are used to control relays. One end of the relay should be connected to switched B+, while the other side is connected to a software controlled ON/OFF switch inside the control unit.

The relay can be normally–on or normally–off depending on how the VIP outputs are configured. The control unit provides for three of these VIP output connections. See Table 3.

The function of these VIP outputs can be defined by field programming the control unit. Typical applications for VIP outputs are external horn/lights alarm and horn ring transfer relay control. For further information on VIP outputs, see the control unit programming manual.

4.2 VIP INPUT CONNECTIONS

The VIP input pins are located on the back of the control unit below the area labeled "VIP." These connections are used to accept inputs from switches. One side of the switch is connected to ground while the other side is connected to a buffered input to the control unit. The switch can be normally–closed or normally–open depending on how the VIP inputs are configured. The control unit permits three of these VIP input connections. See Table 4.

The function of these VIP inputs is defined by field programming the control unit. Typical applications for the VIP inputs are for a foot switch or a horn ring switch. For further information on VIP inputs, see the control unit programming manual.

5. Power Connections

CAUTION

Use only *SYNTOR X 9000* cable kits. Connection to other cable kits or control panels may cause electrical damage.

Replace the fuse in the in–line fuseholder of the red power cable coming from the radio in the trunk. Also connect the green (and/or orange) fused wire(s) coming from the control unit to the ungrounded terminal (or source) of the battery.

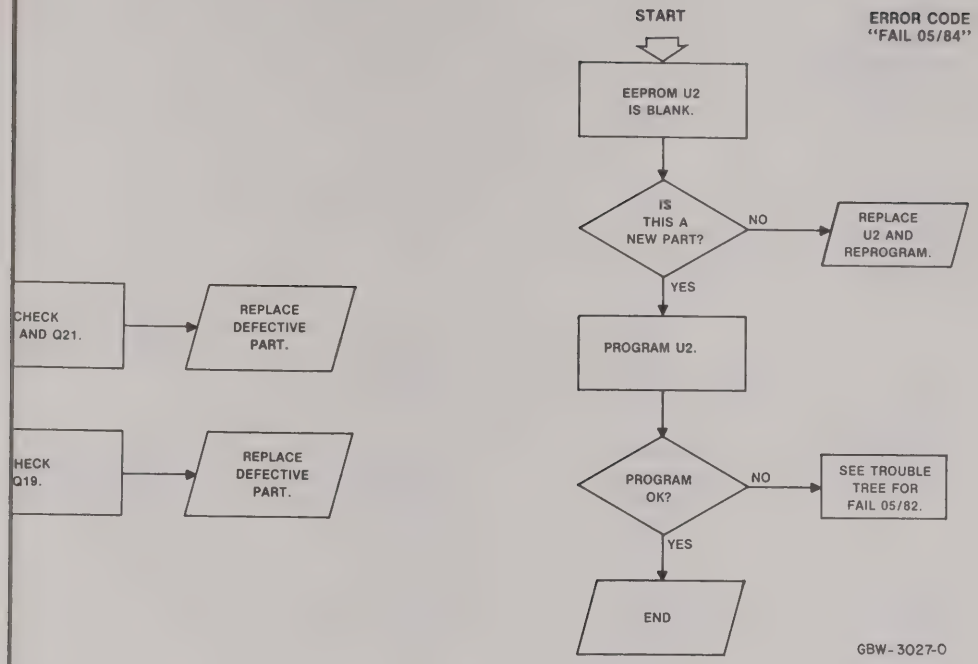
Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Drill 1/8" mounting holes, then attach the clamps with four #8 by 3/8" tapping screws and four 1/4" lockwashers. Finally, be sure all in–line fuses are installed.

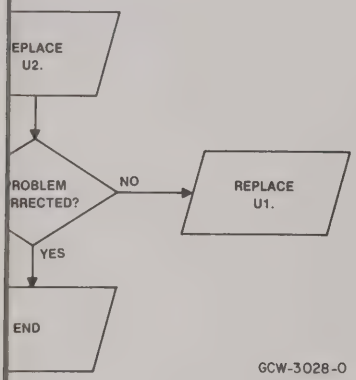
Table 3 . VIP Output Connections

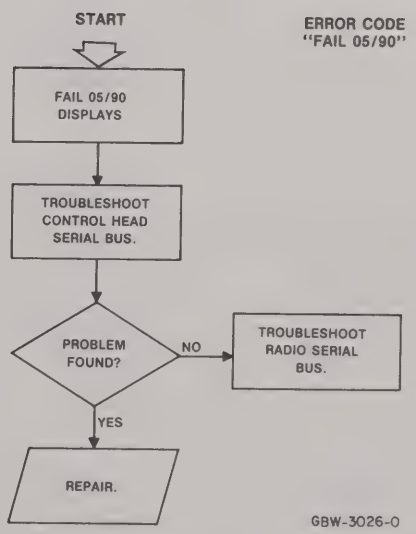
VIP OUTPUT NO.	SWITCHED B+ PIN NO.	ON/OFF SWITCH PIN NO.	DEFAULT FUNCTION IS CHANGED WITH FIELD PROGRAMMER
1	18	2	HORN RELAY (ALARM)
2	19	1	LIGHT RELAY (ALARM)
3	35	34	SIREN–HORN TRANSFER

Table 4. VIP Input Connections

VIP INPUT NO.	GROUND PIN NO.	ON/OFF SWITCH PIN NO.	DEFAULT FUNCTION IS CHANGED WITH FIELD PROGRAMMER
1	20	4	SIREN; HORN RING
2	21	3	EMERGENCY (IF OPTION PRESENT)
3	36	37	NONE







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PW–6220–O
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3.2 RE–ASSEMBLY OF THE CONTROL UNIT

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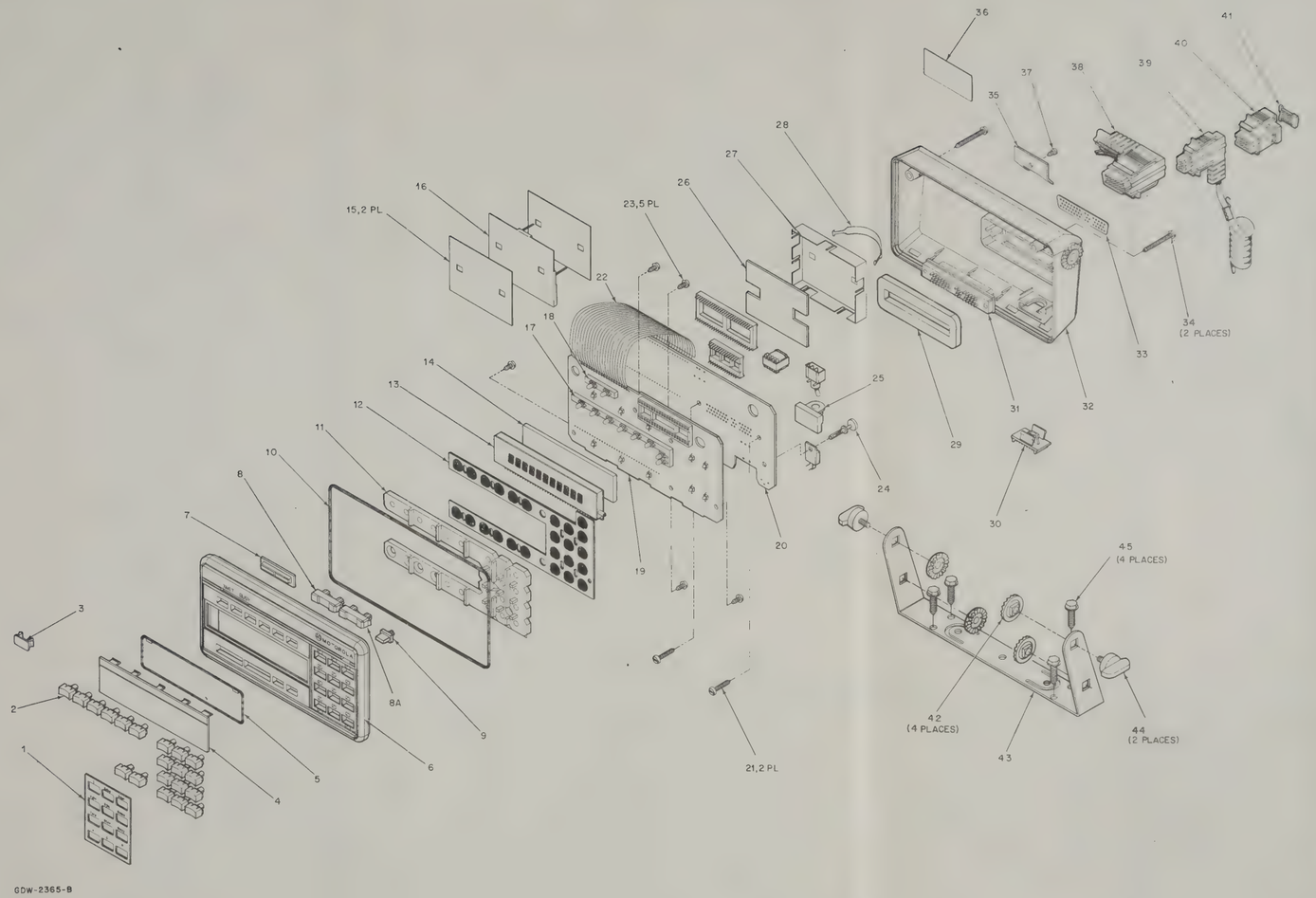
3	36	37	NONE



parts list

Mechanical Parts List for *Systems 9000* Control Unit — MXW–2293–G

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	13–80087J01	escutcheon
2	38–80090J01	push–in key top (specify legend required)
3	38–80253K01	plug key
4	61–80095J01	VF lens
5	32–80057K02	lens gasket
6	15–80088J01	front housing
7	61–80195P03	LED lens
8	38–80195P04	mode rocker top
8A	38–80091J02	volume rocker top
9	38–80092J01	dimmer key top
10	32–80180J02	housing gasket
11	61–80185J02	keyboard lightpipe
12	75–80098J01	elastomeric keypad
13	72–80242J01	VF display
14	75–80184J01	VF shock pad
15	14–80269K01	insulator
16	26–80220K01	solder side shield
17	73–80011L01	LED 8 position spacer
18	43–80012L01	LED 2 position spacer
19	84–80117J01	display PCB
20	84–80104J01	controller PCB
21	03–10945A14	TORX plastite screw, 3.12 x 1.27 x 16
22	30–80034K01	22 position flex cable
23	03–10945A11	TORX plastite screw, 2.12 x 1.27 x 8
24	05–80200K01	nylon rivet
25	32–80176J01	on/off gasket
26	75–80268K01	IC shock pad
27	26–80003K01	component side shield
28	55–84300B02	shield handle
29	32–80179J01	D connector gasket
30	38–80128J01	on/off key top
31	28–80228J01	50 position D connector
32	15–80089J01	back housing
33	32–80181J01	connector face gasket
34	03–10908A33	TORX machine screw, 3.0 x .6 x 30, 2 used
35	07–84323C01	strain relief bracket
36	33–80178M01	nameplate
37	03–10908A18	TORX machine screw, 3.0 x .5 x 6
38	30–80229N01	radio cable
39	30–80223J01	microphone cable
40	15–80221J01	vehicle interface port connector
41	32–80275K01	VIP gasket
42	43–80127J01	trunnion spacer
43	07–80263L01	trunnion bracket
44	03–80160E01	wing screw, 2 used
45	03–00136756	mounting screw, 4 used

7/31/89

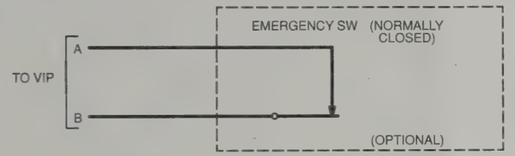
Exploded View and Parts List
for Control Unit
PW–2425–F
7/31/89

parts list

HKN4241A 17' Negative Ground Cable Kit — MXW–2046–A

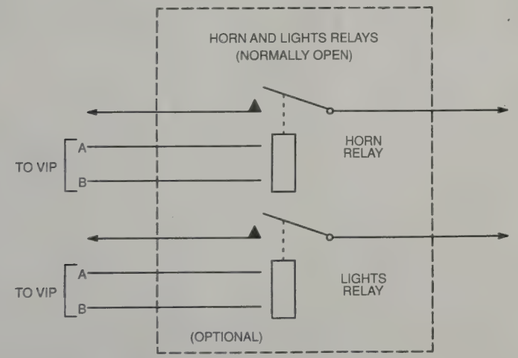
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	01–80739T54	17' cable assembly
	29–84528B05	lug
	30–00851875	battery cable, black
	01–80701T89	66" black lead and lug assembly
	09–84151B03	contact receptacle
	09–84151B05	contact receptacle
	30–80229N01	radio cable
	39–10184A44	contact receptacle, 2 used
	15–10183A17	2 contact receptacle housing
	36–80220B06	connector knob
	03–00140079	tapping screw, 6 x 19 x 1/2, 4 used
	42–10217A02	tie strap, 2 used
	42–80156B01	retainer ring
	09–80227B01	power contact, female, 2 used
	15–80217K01	front cable housing
	15–80216B01	back cable housing
	32–80004L01	cable connector gasket
	30–00812505	8 gage cable, red
	30–10286C79	20 strand wire, white/blue
	30–10286F21	20 strand wire, black/violet
	54–80072G01	circuit board label
	54–84032M02	label

5/10/88



NOTE:
VIP INPUTS ARE PROGRAMMABLE. THIS MEANS VIP IN #1, VIP IN #2, OR VIP IN #3 COULD BE MADE AN EMERGENCY SWITCH DEPENDING ON HOW THE CONTROL HEAD IS PROGRAMMED. THE OTHER SWITCH CONTACT SHOULD BE CONNECTED TO DIG GND PINS 20, 21, OR 26.

GPW–3002–B

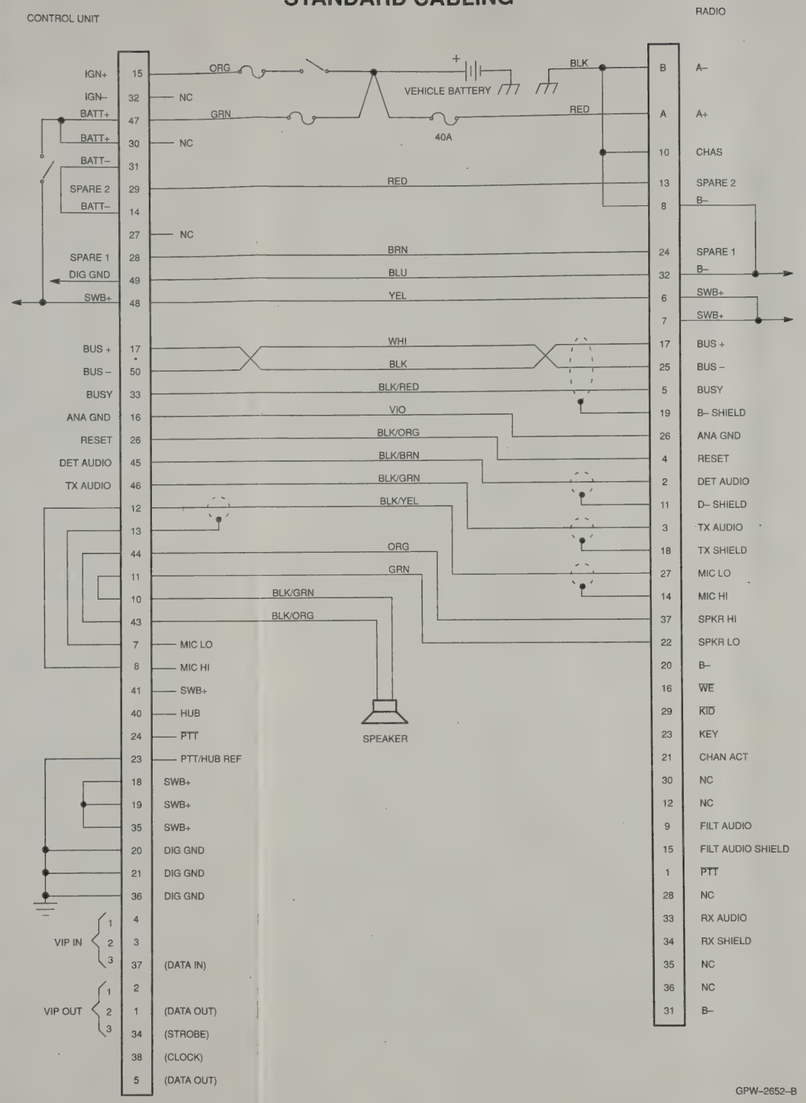


NOTE:
VIP OUTPUTS ARE PROGRAMMABLE. ONE CONTACT OF THE RELAY SHOULD BE CONNECTED TO THE VIP OUTPUT PROGRAMMED FOR THE RELAY AND THE OTHER CONTACT TO SW B+ PINS 18, 19, OR 35.

GPW–3003–A

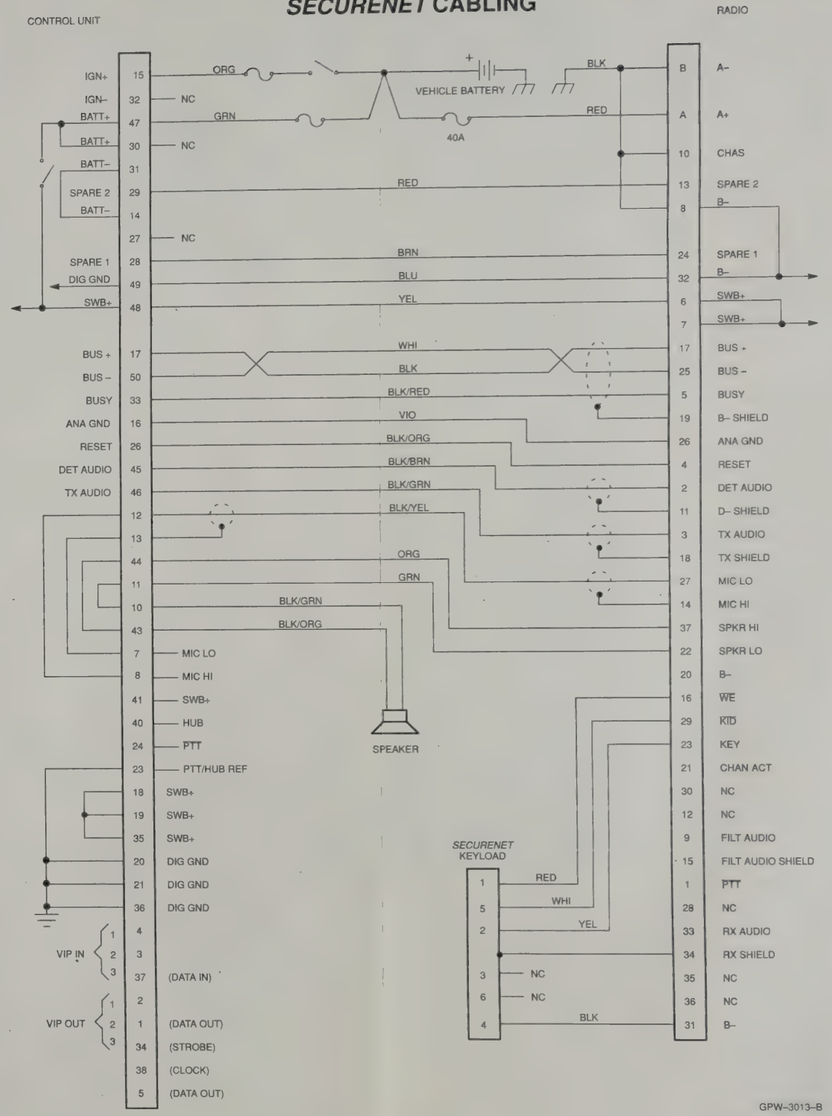
Negative Ground Cable
Wiring Diagrams
PW–2779–D
7/14/89

STANDARD CABLING



GPW–2652–B

SECURENET CABLING



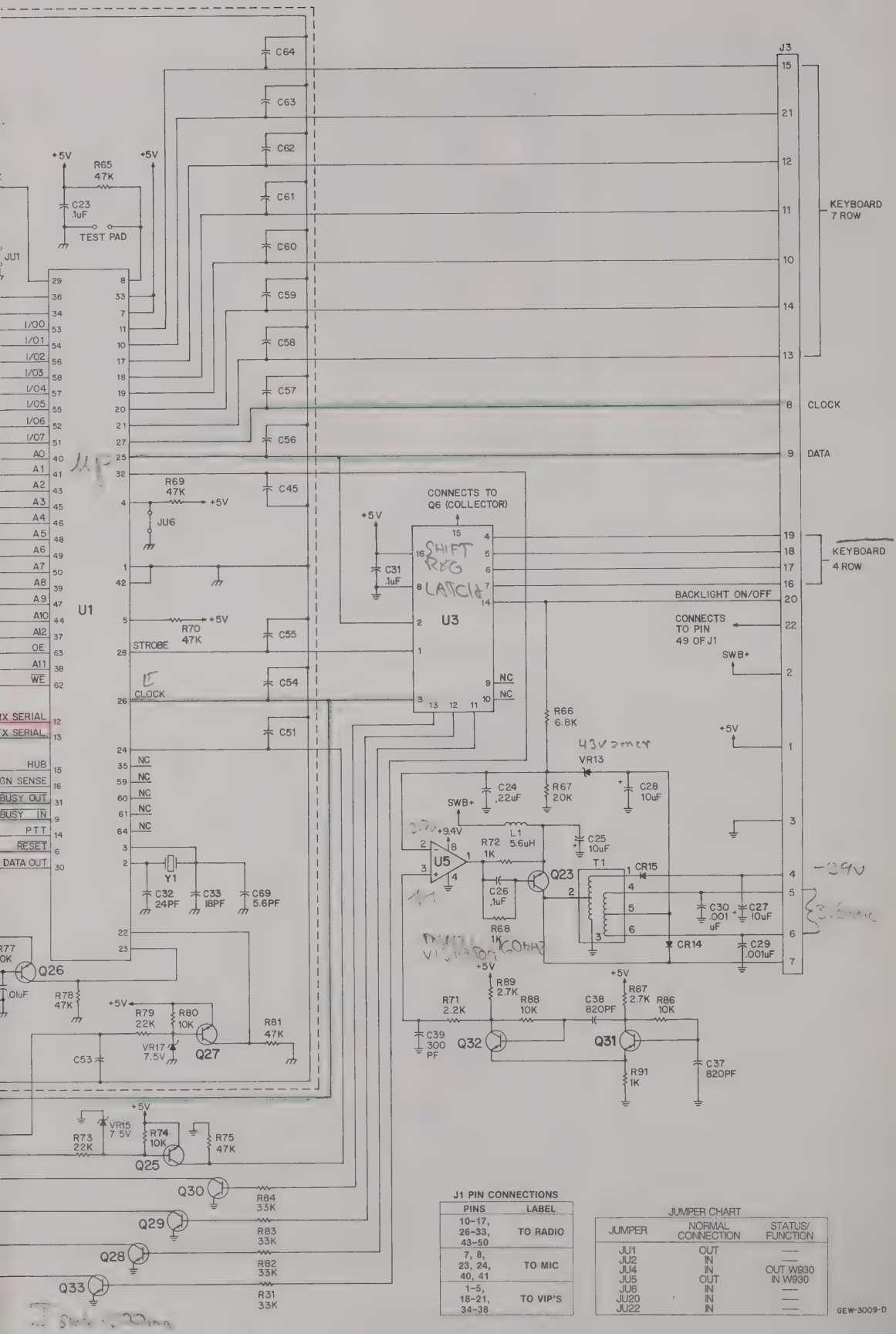
GPW–3013–B

ROLA NO.	DESCRIPTION
(unless otherwise stated)	
32B13	.1, +80, –20%
40B60	300 pF
48C05	1, ±20%, 63V, electrolytic
32B01	.001, +80, –20%
40B57	220 pF
48C10	10, ±20%, 63V, electrolytic
48C05	1 ±20%, 63V, electrolytic
40B39	39 pF
48C06	2.2, ±20%, electrolytic
32B13	.1, +80, –20%
32B13	.1, +80, –20%
32B15	.22, +80, –20%
54H08	10, ±10%, 25V, tantalum
32B13	.1, +80, –20%
48C10	10, ±20%, 63V, electrolytic
32B01	.001, +80, –20%
32B13	.1, +80, –20%
40B34	24 pF
40B31	18 pF
40B71	820 pF
40B60	300 pF
41N45	.01, ±10%
40B19	5.6 pF, ±.5 pF, 50V
41N45	.01, ±10%
40B39	39 pF
40B57	220 pF
40B60	300 pF
41N45	.01, ±10%
40B60	300 pF
36E08	silicon
36E08	silicon
54H01	silicon
36E08	silicon
66H18	rectifier
16A11	silicon
77A01	0 ohm
77A01	0 ohm
77A01	0 ohm
28J01	50 contact mini D connector
38G04	5.6 uH, ±5%
41L01	PNP
41L03	PNP
41L04	NPN
82D22	SCR
41L03	PNP
41L04	NPN
41L03	PNP
41L04	NPN
82D11	NPN
41L04	NPN
41L01	PNP
41L03	PNP
41L04	NPN
41L03	PNP
41L02	NPN
41L03	PNP
41L02	NPN
69732	PNP
41L03	PNP
82D28	NPN
41L02	NPN
41L02	NPN
82D08	NPN
41L04	NPN
watt (unless otherwise stated)	
77A82	2.2k
77A98	10k
77A90	4.7k
77A50	100
77A90	4.7k
77A98	10k
77A82	2.2k
77B05	18k
77B31	220k
77A90	4.7k
77B23	100k
77B11	33k
77A98	10k
77A90	4.7k
77B15	47k
77B11	33k
77A98	10k
77A36	27
77A74	1k
77B07	22k
77A98	10k
77B15	47k
77A90	4.7k
77B11	33k
77A70	680
77A82	2.2k
77A98	10k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R49	06–11077B15	47k
R50	06–11077A90	4.7k
R51	06–11077A86	3.3k
R52	06–11077A90	4.7k
R53	06–11077A74	1k
R54	06–11077B07	22k
R55	06–11077A98	10k
R56	06–11077A90	4.7k
R57,58	06–11077A98	10k
R59	06–11077B15	47k
R60	06–11077A90	4.7k
R61–62	06–11077B15	47k
R63	06–11077A98	10k
R64	06–11077A66	470
R65	06–11077B15	47k
R66	06–11077A94	6.8k
R67	06–11077B06	20k
R68	06–11077A74	1k
R69,70	06–11077B15	47k
R71	06–11077A82	2.2k
R72	06–11077A74	1k
R73	06–11077B07	22k
R74	06–11077A98	10k
R75	06–11077B15	47k
R76	06–11077B07	22k
R77	06–11077A98	10k
R78	06–11077B15	47k
R79	06–11077B07	22k
R80	06–11077A98	10k
R81	06–11077B15	47k
R82–84	06–11077B11	33k
R86	06–11077A98	10k
R87	06–11077A84	2.7k
R88	06–11077A98	10k
R89	06–11077A84	2.7k
R91,92	06–11077A74	1k
R94–96	06–11077A70	680
R97	06–11077A36	27
R99	06–11077A36	27
switch		
S1	40–80033K01	toggle
transformer		
T1	25–80277J03	voltage conversion
integrated circuit (see note)		
U1	———	control unit software (see model chart)
U2	———	EEPROM software (see model chart)
U3	51–83627M42	bipolar
U4	51–80067C05	opamp
U5	51–80046K01	compartor
U7	51–80068C02	voltage regulator
varactor (see note)		
VR1–4	48–80140L11	7.5V zener
VR9	48–82256C67	10V zener, 1W
VR13	48–80236E14	43V zener
VR15–17	48–80140L11	7.5V zener
crystal (see note)		
Y1	48–80113K03	4.9152 MHz
	non–referenced items	
	01–80740T41	component side shield assembly
	26–80003K01	component side shield
	55–84300B02	handle
	05–80200K01	nylon rivet
	09–80002K01	IC socket
	09–80269B03	dual IC socket
	14–80076L01	insulator shield
	14–80269K01	insulator
	26–80220K01	solder side shield
	29–10134A68	connector lug, 6 used
	32–80179J01	D connector gasket
	32–80181J01	face connector gasket
	43–80011L01	8 position LED spacer
	43–80012L01	2 position LED spacer
	54–80111F01	PROM label
	75–05295B01	crystal base pad
	75–80098J01	keypad
	75–80184J01	VF shock pad
	75–80268K01	IC shock pad
	29–10134A70	connector lug, 6 used

9/28/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



J1 PIN CONNECTIONS

PINS	LABEL
10-17, 26-33, 43-50	TO RADIO
7, 8, 23, 24, 40, 41	TO MIC
1-5, 18-21, 34-38	TO VIP'S

JUMPER CHART

JUMPER	NORMAL CONNECTION	STATUS/ FUNCTION
JU1	OUT	—
JU2	IN	—
JU4	IN	OUT W930
JU5	OUT	IN W930
JU6	IN	—
JU20	IN	—
JU22	IN	—

GEW-3009-D

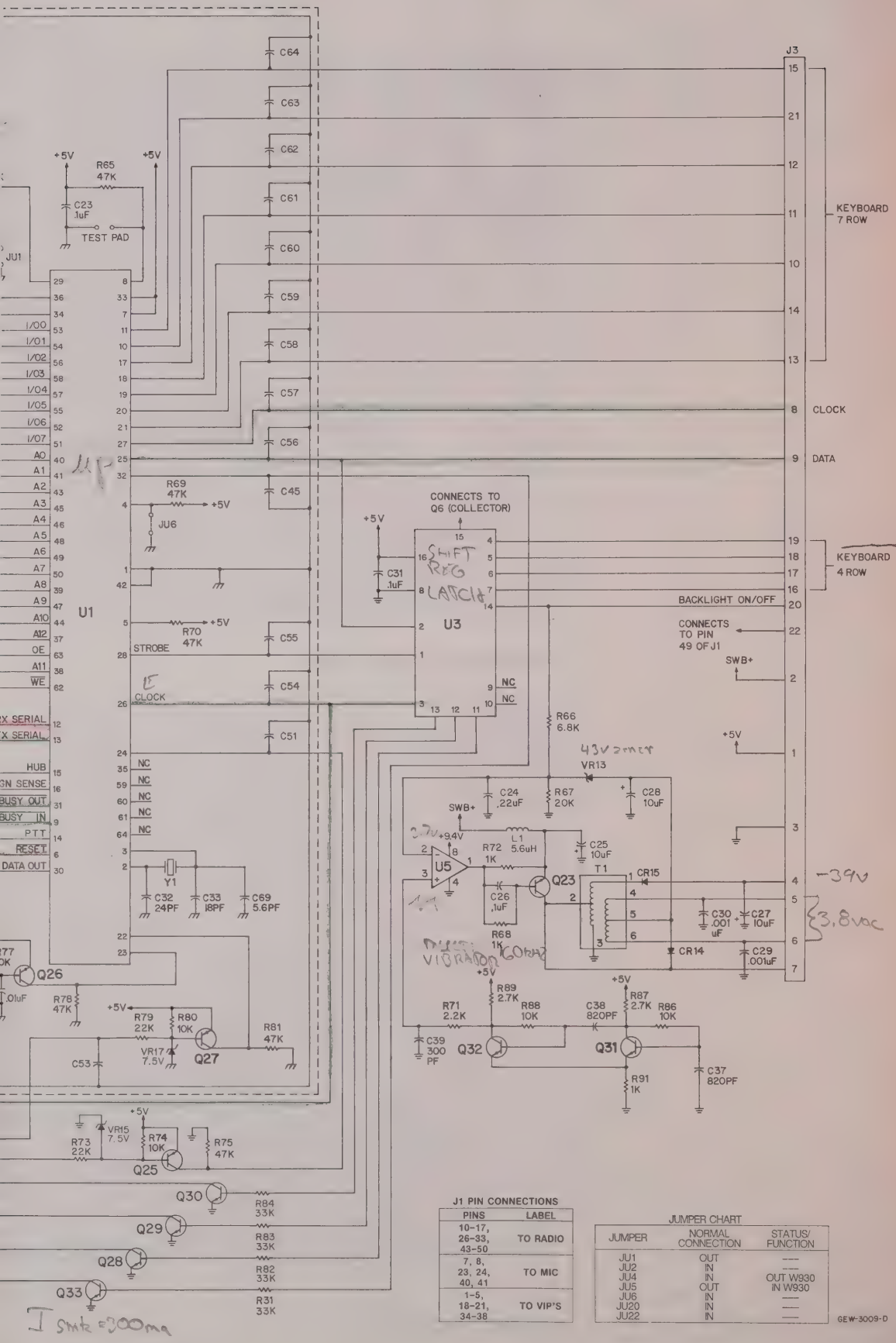
parts list

Mechanical Parts List for *Systems 9000* Control Unit MXW–2293–G

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	13–80087J01	escutcheon
2	38–80090J01	push–in key top (specify legend required)
3	38–80253K01	plug key
4	61–80095J01	VF lens
5	32–80057K02	lens gasket
6	15–80088J01	front housing
7	61–80195P03	LED lens
8	38–80195P04	mode rocker top
8A	38–80091J02	volume rocker top
9	38–80092J01	dimmer key top
10	32–80180J02	housing gasket
11	61–80185J02	keyboard lightpipe
12	75–80098J01	elastomeric keypad
13	72–80242J01	VF display
14	75–80184J01	VF shock pad
15	14–80269K01	insulator
16	26–80220K01	solder side shield
17	73–80011L01	LED 8 position spacer
18	43–80012L01	LED 2 position spacer
19	84–80117J01	display PCB
20	84–80104J01	controller PCB
21	03–10945A14	TORX plastite screw, 3.12 x 1.27 x 16
22	30–80034K01	22 position flex cable
23	03–10945A11	TORX plastite screw, 2.12 x 1.27 x 8
24	05–80200K01	nylon rivet
25	32–80178J01	on/off gasket
26	75–80268K01	IC shock pad
27	26–80003K01	component side shield
28	55–84300B02	shield handle
29	32–80179J01	D connector gasket
30	38–80128J01	on/off key top
31	28–80228J01	50 position D connector
32	15–80089J01	back housing
33	32–80181J01	connector face gasket
34	03–10908A33	TORX machine screw, 3.0 x .6 x 30, 2 used
35	07–84323C01	strain relief bracket
36	33–80178M01	nameplate
37	03–10908A18	TORX machine screw, 3.0 x .5 x 6
38	30–80229N01	radio cable
39	30–80223J01	microphone cable
40	15–80221J01	vehicle interface port connector
41	32–80275K01	VIP gasket
42	43–80127J01	trunnion spacer
43	07–80263L01	trunnion bracket
44	03–80160E01	wing screw, 2 used
45	03–00136756	mounting screw, 4 used

7/31/89

Exploded View and Parts List
for Control Unit
PW–2425–F
7/31/89



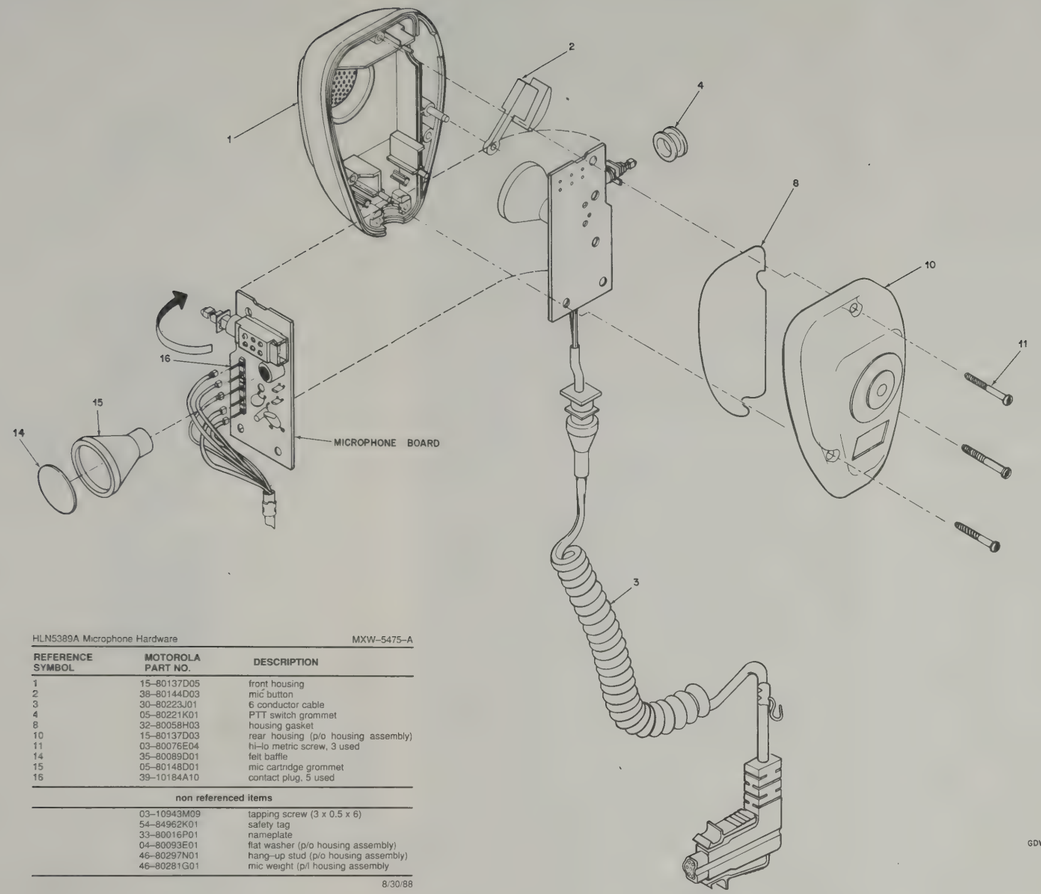
J1 PIN CONNECTIONS

PINS	LABEL
10–17, 26–33, 43–50	TO RADIO
7, 8, 23, 24, 40, 41	TO MIC
1–5, 18–21, 34–38	TO VIP'S

JUMPER CHART

JUMPER	NORMAL CONNECTION	STATUS/ FUNCTION
JU1	OUT	---
JU2	IN	---
JU4	IN	OUT W930
JU5	OUT	IN W930
JU6	IN	---
JU20	IN	---
JU22	IN	---

GEW-3009-D



GDW-2049-A

HLN5389A Microphone Hardware MXW-5475-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D05	front housing
2	38-80144D03	mic button
3	30-80223J01	6 conductor cable
4	05-80221K01	PTT switch grommet
8	32-80058H03	housing gasket
10	15-80137D03	rear housing (p/o housing assembly)
11	03-80076E04	hi-lo metric screw, 3 used
14	35-80089D01	felt baffle
15	05-80148D01	mic cartridge grommet
16	39-10184A10	contact plug, 5 used
	non referenced items	
	03-10943M09	tapping screw (3 x 0.5 x 6)
	54-84962K01	safety tag
	33-80016P01	nameplate
	04-80093E01	flat washer (p/o housing assembly)
	46-80297N01	hang-up stud (p/o housing assembly)
	46-80281G01	mic weight (p/l housing assembly

8/30/88

parts list

HLN4384B Microphone Circuit Board MXW-2051-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed uF, ±5%, 50V (unless otherwise stated)		
C1301	21-11038H35	24 pF
C1302	21-11039B13	.001 ±10%
C1304	23-11019A20	10 ±20% 25V, electrolytic
C1305	08-11017A14	.047
C1306	21-11038P50	220 pF
C1307	21-11039B13	.001 ±10%
C1308	08-11051A14	.15 63V
diode (see note)		
CR1301	48082256C25	12V zener ±5% 400mW
connector receptacle		
JU1301,1302	06-11009B23	0 ohm jumper
microphone		
MK1301	50-80258E04	electret cartridge
transistor (see note)		
Q1302	48-80182D08	NPN
resistor, fixed ohm, ±5%, 1/4 watt (unless otherwise stated)		
R1302	06-11009C57	2.2k
R1303	06-11009C49	1k
R1305	06-11009C97	100k
R1306	06-11009C19	56
switch		
S1301	40-80652E02	momentary switch
	mechanical part	
	14-80652E01	switch insulator

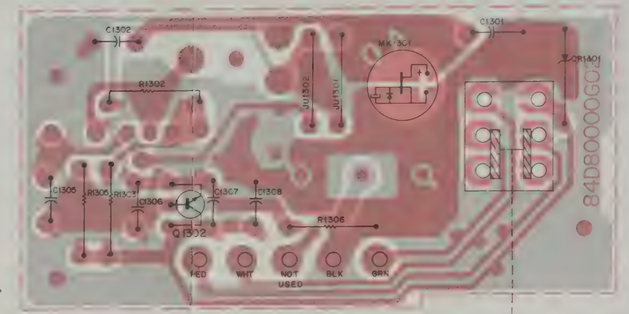
4/19/88

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

HLN4384B MICROPHONE BOARD (EARLY VERSION)

FUNCTION

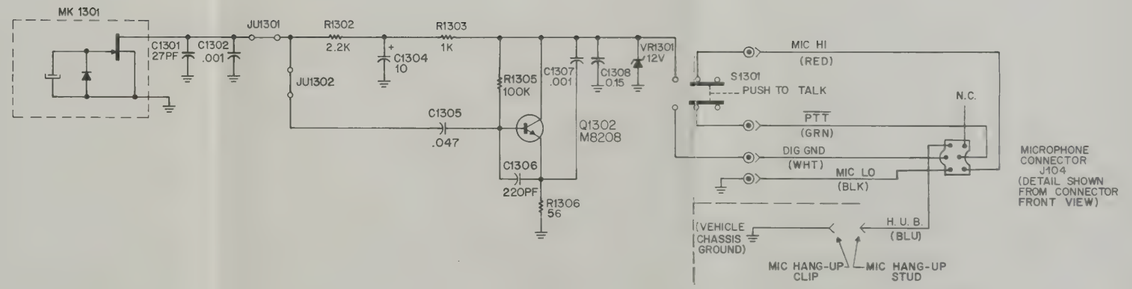
The palm microphone contains an amplifier to provide the radio with a high-level, noise-free audio input. The microphone also provides push-to-talk transmit control for the radio as well as off-hook channel monitoring (PL/DPL squelch disable) capability.



SHOWN FROM SOLDER SIDE

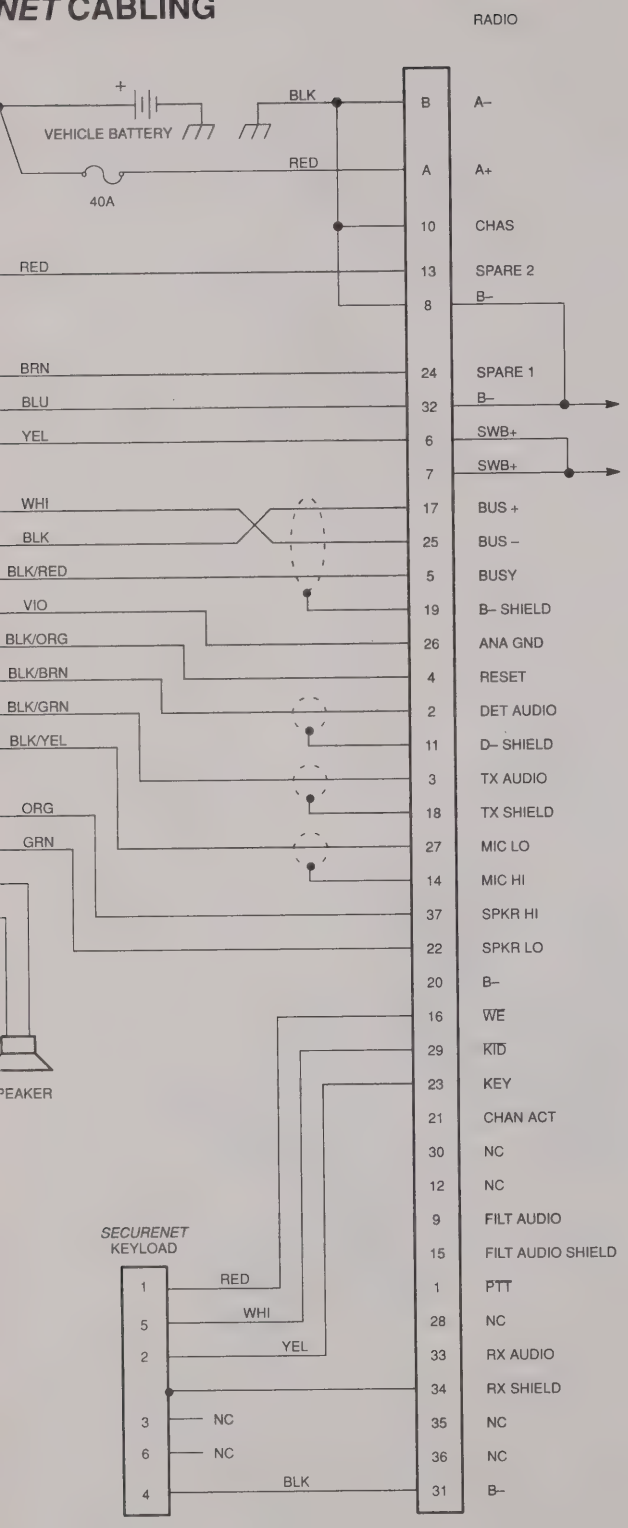
S1301 P.T.T.

COMPONENT SIDE - GBW-3447-A
SOLDER SIDE - GBW-3448-A
OVERLAY - GBW-3449-A



GCW-2050-A

NET CABLING

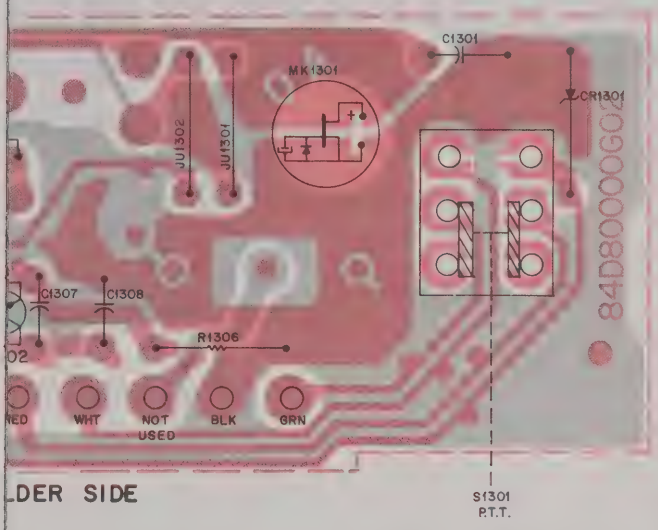


GPW–3013–B

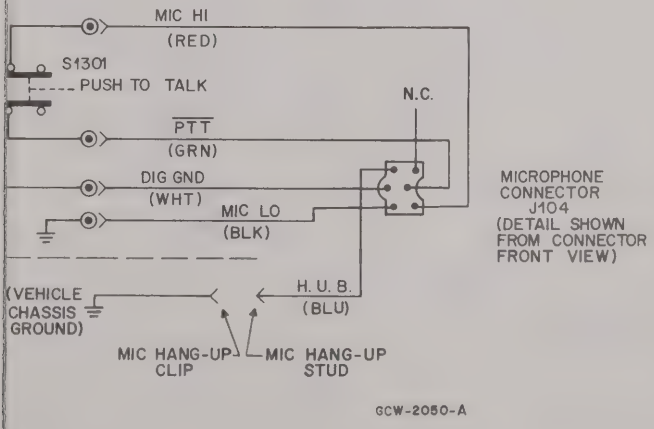
MICROPHONE BOARD (EARLY VERSION)

FUNCTION

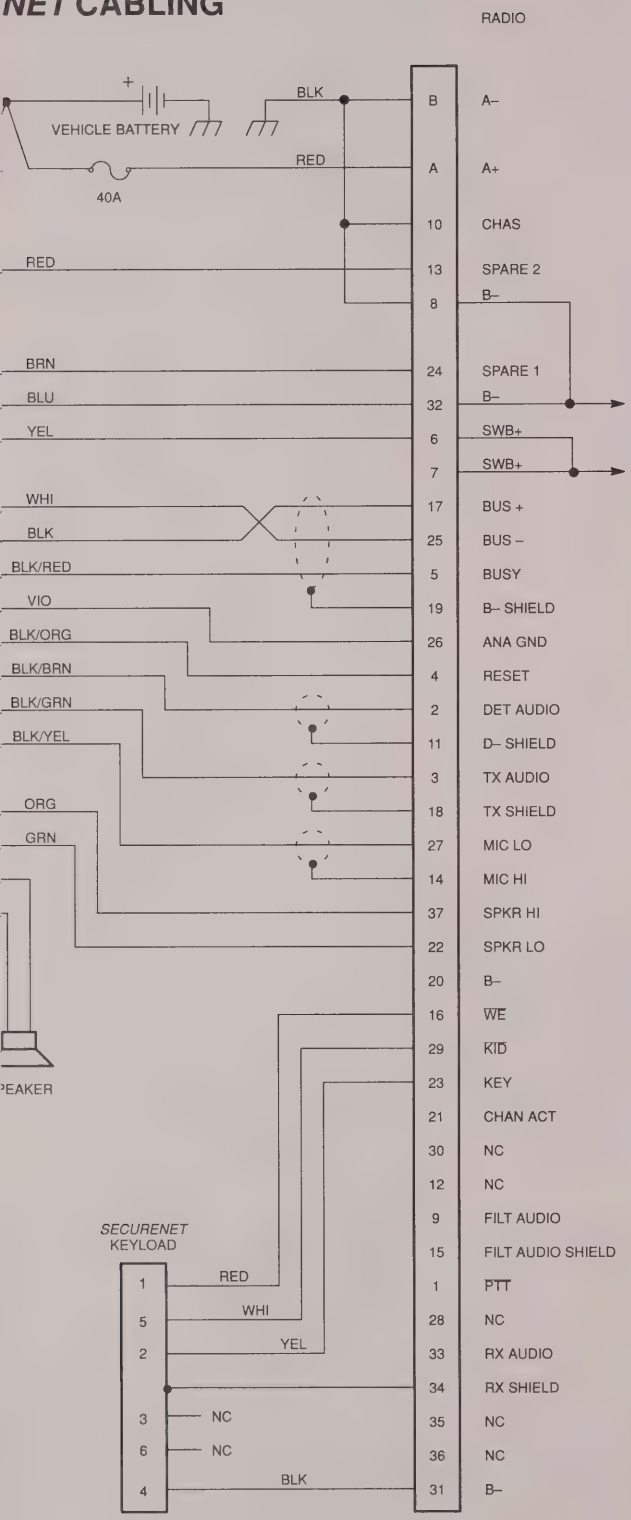
The palm microphone contains an amplifier to provide the radio with a high-level, noise-free audio input. The microphone also provides push-to-talk transmit control for the radio as well as off-hook channel monitoring (PL/DPL squelch disable) capability.



COMPONENT SIDE - GBW-3447-A
SOLDER SIDE - GBW-3448-A
OVERLAY - GBW-3449-A

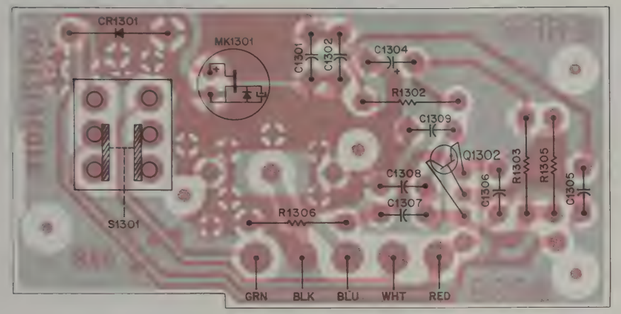


NET CABLING



GPW–3013–B

HLN5459A MICROPHONE BOARD (LATER VERSION)



SOLDER SIDE — GBW-6287-O
COMPONENT SIDE — GBW-6288-O
OVERLAY — GBW-6289-O

parts list

HLN5459A Microphone Circuit Board — MXW-6286-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed uF, ±5%, 50V (unless otherwise stated)		
C1301	21-11038H35	24 pF
C1302	21-11039B13	.001 ±10%
C1304	23-11019A20	10 ±20% 25V, electrolytic
C1305	08-11051A11	.047
C1306	21-11038P50	220 pF
C1307	21-11039B13	.001 ±10%
C1308	08-11051A14	.15 63V
C1309	21-11014H44	62pF, 100V
diode (see note)		
CR1301	48-11034A36	12V zener ±5% 400mW
microphone		
MK1301	50-80258E04	electret cartridge
transistor (see note)		
Q1302	48-11043C05	NPN
resistor, fixed ohm, ±5%, 1/4 watt (unless otherwise stated)		
R1302	06-11009A57	2.2k
R1303	06-11009A49	1k
R1305	06-11009A97	100k
R1306	06-11009A19	56
switch		
S1301	40-80065E02	momentary switch
mechanical part		
	14-80652E01	switch insulator

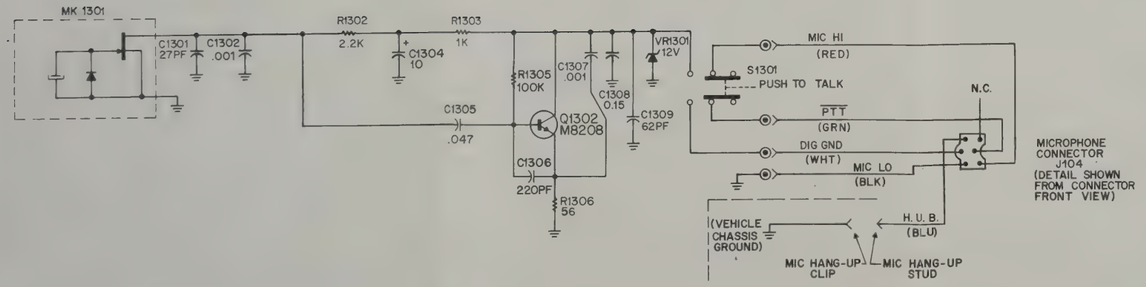
2/15/89

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

HLN5389A Microphone Hardware — MXW-5475-A

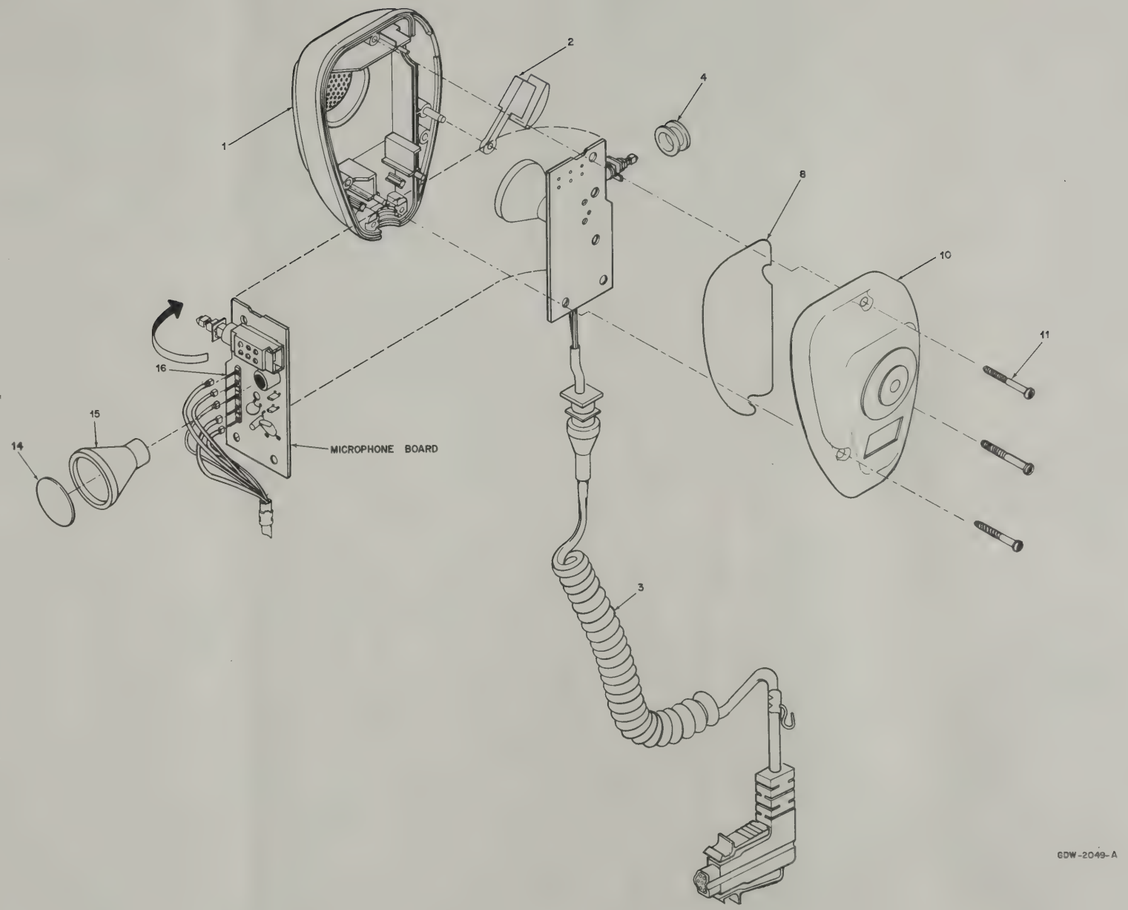
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D05	front housing
2	38-80144D03	mic button
3	30-80223J01	6 conductor cable
4	05-80221K01	PTT switch grommet
8	32-80058H03	housing gasket
10	15-80137D03	rear housing (p/o housing assembly)
11	03-80076E04	hi-lo metric screw, 3 used
14	35-80089D01	felt baffle
15	05-80148D01	mic cartridge grommet
16	39-10184A10	contact plug, 5 used
non referenced items		
	03-10943M09	tapping screw (3 x 0.5 x 6)
	54-84962K01	safety tag
	33-80016P01	nameplate
	04-80093E01	flat washer (p/o housing assembly)
	46-80297N01	hang-up stud (p/o housing assembly)
	46-80281G01	mic weight (p/l housing assembly

8/30/88

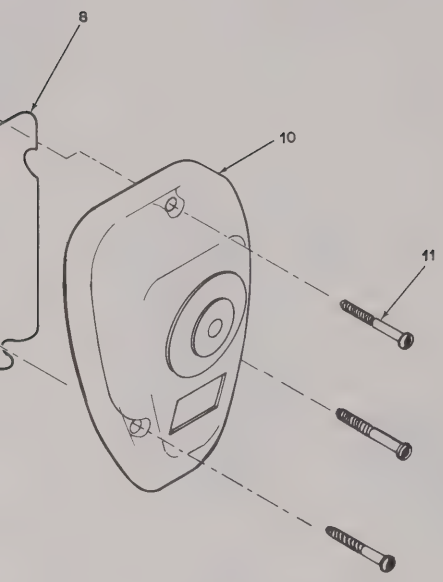


GCW-6290 O

MICROPHONE CONNECTOR J104 (DETAIL SHOWN FROM CONNECTOR FRONT VIEW)

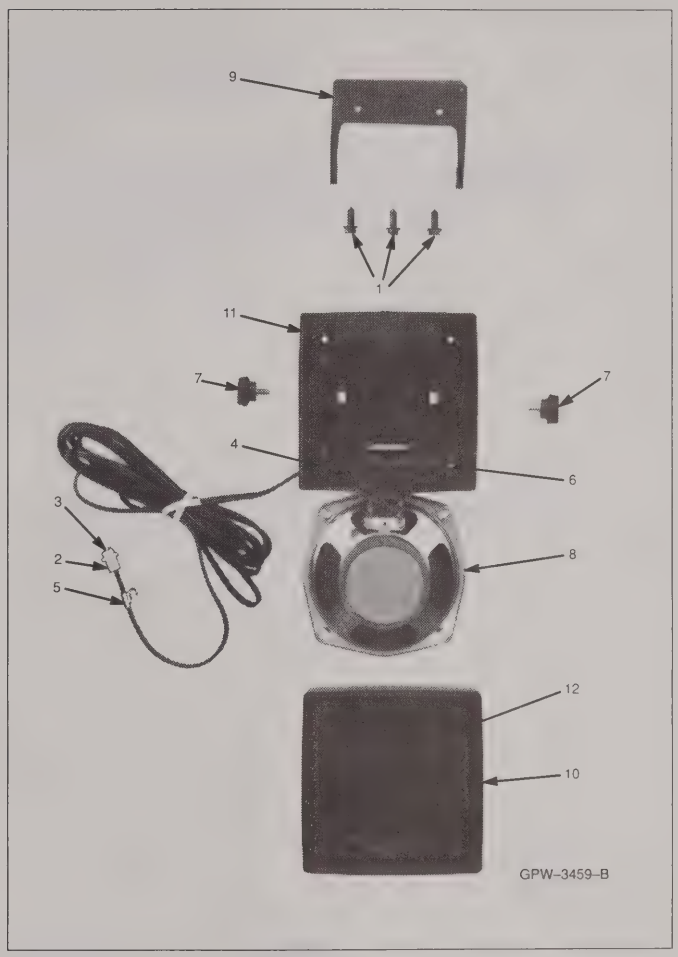


GDW-2049-A



GDW-2049-A

HSN4018A SPEAKER AND ACCESSORIES



parts list

HLN4022C Installation Kit — MXW–6475–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	03–12002A28	screw, self–drilling, 1/4–14 x 1–1/2" (3 used)
	04–00007688	lockwasher, 1/4
	29–00812980	terminal, closed–end
	37–00081057	grommet, rubber, 1/2"
	42–80366B66	cable tie (10 used)
	43–82292M01	bushing, spacer (3 used)

4/11/89

HSN4018A Speaker — MXW–2053–D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	03–00136756	tapping screw (10–16x 5/8)
2	15–10183A18	connector housing plug, 2–contact
3	39–10184A45	contact plug, 2 used
4	42–82018H05	cable retainer
5	42–84081A03	wire clamp with S–hook
6	03–00140001	tapping screw (6–19 x 7/8), 4 used
7	03–84244C03	black shadow wing screw, 2 used
8	50–84561B01	speaker
9	07–80200E01	black speaker trunnion bracket
10	13–82671M04	bezel
11	15–84981B07	speaker base cover
12	32–84564B01	speaker gasket

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3. ☐ Contain major errors
4. ☐ Are difficult to follow

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☐ **Removal and Replacement of Chip Components on Circuit Boards** 68P81113E77
Contains general information and repair procedures relative to chip-type (leadless) components.

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MXW–0378–A

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